HISTORY RECOVERED:
SAGA OF THE 1792 SILVER DISME

By

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The Resolute Americana Collection

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Argonne National Laboratory

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INTRODUCTION

This paper is a about a journey of discovery that entails the most extensive and intensive scientific examination ever conducted in the field of numismatics. The target of this groundbreaking investigation is a 1792 silver disme Judd-9, Figure 1. It is one of the great rarities from the 1792 US Mint pattern coinage. As a result of over 800 hours of investigations that included photographic analysis, the use of two types of scanning electron microscopes and a historic first for numismatics, the use of synchrotron-radiation-based X-ray micro-diffraction (μ-XRD) technique at the Advanced Photon Source (APS) of the Argonne National Laboratory (ANL) to recover images from the subsurface metal lattice over a period of nearly 2 ½ years, we conclude this coin is THE design work surface for one of the first two coins of the United States, a 1793 half cent. Additionally, we also believe it entails a potential love story.

Though small at 22 mm in diameter, we view this Judd-9 coin as being extremely important, given the message it conveys on its obverse, "LIBERTY PARENT OF SCIENCE AND INDUSTRY." We believe there is no earlier example of coinage espousing this ethos in nearly 2,400 years of numismatic history. The legend captures what would become the driving forces in the development of the United States which were science and industry. During the process that established the Mint Act of April 2, 1792, a debate ensued as to whether the use of a sitting president's bust, name and number of his presidency, was appropriate. The vote was against their employment; instead, the design called for a representation "Emblematic of Liberty" accompanied by an inscription of the word "Liberty."[1] Our future coinage would not follow in the tradition of earlier coinage where power and prestige would be conveyed by images of monarchs, generals or in paying homage to various deities. We would create a coinage that reflected our independence from such tyranny! The 1792 pattern coins are among the rarest and most historically important in US numismatics. Thomas Jefferson, Alexander Hamilton and George Washington, three of our our most important leaders, were among those who were associated with their creation. By unraveling the hidden mysteries of this coin, my colleague, Tony Lopez, and I feel confident that we have enhanced the understanding of how one of the first US coins was designed and, possibly, by whom.

Figure 1. Judd-9 F15 NGC, subject of investigation
Ex. Robert R. Simpson (Heritage Auctions, 1/7/16), Resolute Americana Collection.

[1] Smith, Pete, Joel J. Orosz, Leonard Augsburger. *1792: Birth of a Nation's Coinage.* (Dallas, TX: Ivy Press, Inc., 2017), 31.

What is this project and why is it important?

There are several marks, etches or scratches that have been identified in every auction lot occurrence of Figure 1 for nearly 160 years. As such, until now, this was nothing more than a rare 1792 Mint pattern coin that had surface "issues." They have been considered to be of little importance; however, is this true? The goal of this project sought to unravel what these etch marks were and if they were important. If we were successful in determining their nature, this discovery could potentially lead to a better understanding of our first coinage. We were skeptical about whether we could accomplish this goal. Little did we know we were embarking upon a four-year journey of advanced scientific research that would lead us to several different laboratories. Throughout the course of this endeavor, we experienced many twists and turns that challenged our capabilities as well as our patience. However, during this process, we had the opportunity to meet many extraordinary people with incredible talents.

After four years and during the height of Covid-19, the amazing scan image in Figure 2 was captured from a Judd-9a silver disme, exemplifying the power and capabilities of μ-XRD analysis. The recovered date image, in our opinion, has not been seen since it was effaced from the surface in 1792. This exhibit has opened doors for us at The British Museum and The Mount Vernon George Washington Museum relating to other research projects. Its successful recovery by Dr. Wenjun Liu required 28 hours of μ-XRD scanning at a depth of approximately 50 microns, according to his estimate. When it first appeared, we were stunned by its clarity and dimensionality and that history was truly being recovered. This Judd-9a became the third of three 1792 mint pattern coins subjected to μ-XRD analysis, with the second being a Judd-5 Birch Cent that is covered in Appendix 5.

Figure 2. Judd-9a date recapture, July 2020, Dr. Wenjun Liu
Ex. Donald G. Partrick (Heritage Auctions, 1/8/2015), Florida Collection [David Quint], Resolute Americana

What μ-XRD provides is an opportunity to reexamine our previously held assumptions and convictions about antiquities that were considered to be "settled" history. Throughout our research, whenever we thought we had the "answer," we experienced a surprise that challenged our former view. In order to reach valid conclusions, it is imperative to keep an open mind and be willing to allow the scientific process to unfold.

At its basic level, this is a detective investigation utilizing different analytical methods to unravel a story that has lain hidden for nearly 230 years.

For clarity of identification, when "I" is referenced, this refers to Robert L. Rodriguez.

BACKGROUND

In my coin collecting pursuits, little did I know, as I flew to Heritage Auctions in Dallas, Texas, on December 14, 2015, I would be embarking on an odyssey that would change, and greatly enhance, my life. I was going there to view Lot 5304, a 1792 silver pattern disme, F-15 NGC, that is one of only three known silver examples. This coin had not sold since 2000, and before that, in 1946. It has generally been viewed as a "flawed" coin. In the historic auction of the Lorin G. Parmelee collection by Bangs & Co in June 1890, Lot 1 contained the following description, "… has had several initials scratch on both sides, and then partly burnished to remove them…," while Heritage Auction's lot description stated, "The present coin shows evidence of smoothing and polishing, as well as remnants of some old inscriptions that are mentioned in Cogan's letter in 1864 (Appendix 1), 'It is but right to state, that when I purchased it there were several scratches upon it, which have been very carefully removed, and the Coin is now in very excellent condition.'" While in lot viewing, these "scratches" began to "speak" to me. In my mind, they did not appear to be random marks but more like they were made with intention and meaning. Given their relatively small size, 3 to 5 mm in height, it did take some imagination to see them as being more than random. Could there be a story here? If there were, how would I go about unraveling it? What might it mean? To untangle its mysteries, I would need to find my equivalent of the Rosetta Stone. But before any of this could take place, I needed to acquire the coin. On January 7, 2016, the auction took place. When the third and final bid warning was announced, my heart was pounding so loudly I could barely hear the auctioneer. The gavel came down and it was announced "sold." I exhaled with a great sigh of relief. It was now part of my Resolute Americana Collection, which is a numismatic collection that specializes in early American coinage and historic medals, along with British and Spanish coinage that relate to the formation and establishment of our country and its coinage. I had acquired it for $329,000 versus the $205 Mr. George Seavey paid Edward Cogan in 1864, which equates to approximately a 5% compound rate of appreciation. What this again confirms, despite the coin's "flaws," it has brought significant prices because of its rarity and historical importance.

Now that I owned the coin, how would I go about the necessary research? I would need assistance. Tony Lopez was very much interested in this project, given his research focus on colonial and Revolutionary War medallic and numismatic history. His superb photo imaging capabilities would prove to be a critical element at the beginning of our investigation. We were skeptical about the prospect of being able to uncover the lost information and decode its meaning. Initially, we had little idea of where we were going or what we would possibly discover. We brainstormed several ideas about the meaning of its various etches. New investigative tools would be required to accomplish the task of unraveling this story. We had no knowledge about the critical one, μ-XRD analysis, or what this analytical technique could accomplish. Without the talented professionals at the APS, we could not have successfully accomplished this research investigation.

The importance of this project is not only that it resulted in a major numismatic discovery, but it will introduce the numismatic and antiquities communities to the power and capabilities of synchrotron-radiation-based X-ray micro-diffraction that can safely unlock and recapture information that was thought to be permanently lost. When the initial examination commenced at the Advanced Photon Source, there was not even a name for the research we were conducting there, but it is now referred to as Cultural Heritage Research. We believe this new scientific technique has many potential benefits for historical investigations that are of consequential importance.

While conducting this research, we were amazed by the reactions we received from scientists, engineers and executives who viewed this silver disme. Virtually all said they had never seen anything like it before. They were surprised and awed by the message and spirit it conveyed. When Dr. Dennis Mills, Deputy Associate Laboratory Director for Photon Sciences, saw the legend, of "Science and Industry," he said it truly conveys the mission of the Argonne National Laboratory.

The results of this investigation were originally intended to be presented at the Argonne National Laboratory User Forum in April 2020 but unfortunately, Covid-19 prevented this from happening. The good news is that additional beamline opportunities became available since only APS personnel were allowed into the facility and this project could be executed remotely under the direction of Dr. Wenjun Liu. With the opportunity for more beamline access, our final visit for the 1792 project resulted in the amazing image captured in Figure 2. We then proposed another Cultural Heritage Research project to investigate several other historically important numismatic rarities that culminated in a further 700 hours of μ-XRD analysis. When that project was completed in November 2022, we returned to the 1792 History Recovered project. The findings of the second APS project will be published at a future date.

To complete this investigation, nearly $2 million was spent to attain all the required coins. The additional coins in Figure 3 were acquired, as their need became apparent. Initially, we did not believe the other 1792 silver dismes were essential for this study. The finest, an AU50 NGC, became available on April 28, 2016, at Heritage Auctions, Lot 4571. I had little interest in it, but I would be on the phone with Todd Imhoff of Heritage Auctions listening to the action. At the very last moment on the third and final call, I screamed, "Bid!" I had just realized we might need it for the project. The third and final disme acquisition occurred, when Todd contacted me in early January 2020 and said the Judd-9a was available. On January 13, 2020, it entered the Resolute Collection. Again, we needed it to complete the research study. With these acquisitions, we are quite confident this is the first time since the Mint of 1792 that all three silver dismes are together again. A good deal of luck was needed to accomplish this feat, along with assistance from some very special people, and I thank them for helping to make this possible. As a result of these additions, the investigation was eventually able to be completed.

1792 Silver Thin Planchet Disme Judd-9 AU50 NGC

1792 Silver Disme Judd-9a XF Details NGC

1793 Half Cent Cohen-2 AU55 PCGS

1793 Half Cent Cohen-3 MS64 PCGS

Figure 3. Four additional coins used in the investigation

PROJECT JOURNEY

Our research efforts began slowly, as we conceptualized how we would undertake this journey. We had little appreciation or understanding about the difficulties we would face attempting to unlock the meanings of this coin's various etch marks or "scratches." Were these markings worthy of this effort, despite my feelings they were more than random? The research investigation evolved to include the following elements:

1. PHOTO IMAGING ANALYSIS
2. SCIENTIFIC INVESTIGATIONS
    a. Phase 1: Scanning electron microscopes
    b. Phase 2: Argonne National Laboratory Advanced Photon Source synchrotron radiation facility

And with this, the saga begins.

PHOTO IMAGING ANALYS

The photographic investigation began February 10, 2016, and finished in May 2016, with over 150 hours of imaging. Hundreds of images were reviewed and refined so that we gained a better understanding of what the markings on this coin might represent. We knew from observation that the bust of Liberty on the silver disme looked very much like that used on the 1793 half cent and that we were not the first to see this connection. Figure 4 shows the two primary coins for this comparison, the finest Judd-9 silver disme and a 1793 half cent Cohen-2. We soon substituted a Cohen-2 for the Cohen-3 we were using when it became apparent there was a difference in forehead design.

Silver Disme Judd-9 Half Cent Cohen-2

Figure 4. Comparison coins

Obverse Analysis

The first examination focused on whether the images of Liberty on both coins were similar or exact. In Figure 5 the AU50 NGC Judd-9 silver disme was overlaid upon the 1793 half cent Cohen-2. Both coins have diameters of approximately 22 mm. This overlay clearly proves the profiles are not just similar but are indeed identical from the forehead hairline down to the neck area.[2] This first discovery confirmed to us that these two coins were related but to what extent was still a mystery. Additional photographic analysis was required.

Figure 5. Judd-9 silver disme transparent overlay upon 1793 half cent Cohen-2

In lot viewing of the Judd-9 F15 NGC silver disme, my attention was attracted to two etch marks that would become obverse reference lines: Vertical Reference Line 1 (VR1) being 3 mm in height and Vertical Reference Line 2 (VR2) at 5 mm. Figure 6 denotes these critical reference lines on this coin.

[2] Bill Eckberg, "Hubbing Dies in the Earliest Days of the United States Mint" *The Numismatist* (June 2017): 52-54. This is the first article to identify a Judd-10 copper disme and the 1793 half cent were produced from the same hub to create Liberty. As a result of our overlay studies, we concluded that both images of Liberty were identical and we began our laboratory studies on December 7, 2016, at American Assay Laboratories, Reno, Nevada.

Figure 6. Vertical Reference Lines (VR)

Next, we wanted to determine whether these reference lines were important. If we shifted Liberty to the left and downwards, would its new position match that on the half cent? Our caliper measurements indicated that a shift of approximately 1.1 mm to the left and then downwards by 0.5 mm might achieve this result. Our initial scanning electron microscopic studies would confirm these measurements. Figure 7 shows the intended shifts by the yellow arrow where the upper lip of the half cent, red arrow, should come into alignment on VR1's diagonal portion of Figure 6 VR1. If so, this would be a major confirmation of the importance of VR1.

Figure 7. Liberty bust shift to VR1

Figure 8 provides a close-up view after the prescribed Liberty bust shift. The upper lip of Liberty comes into perfect alignment with the diagonal portion of VR1, red arrow, and matches the red arrow position on the half cent in Figure 7. This proves that VR1 is a critical reference line in the design of the 1793 half cent. We now had a second confirmation that this silver disme was directly linked to the half cent design.

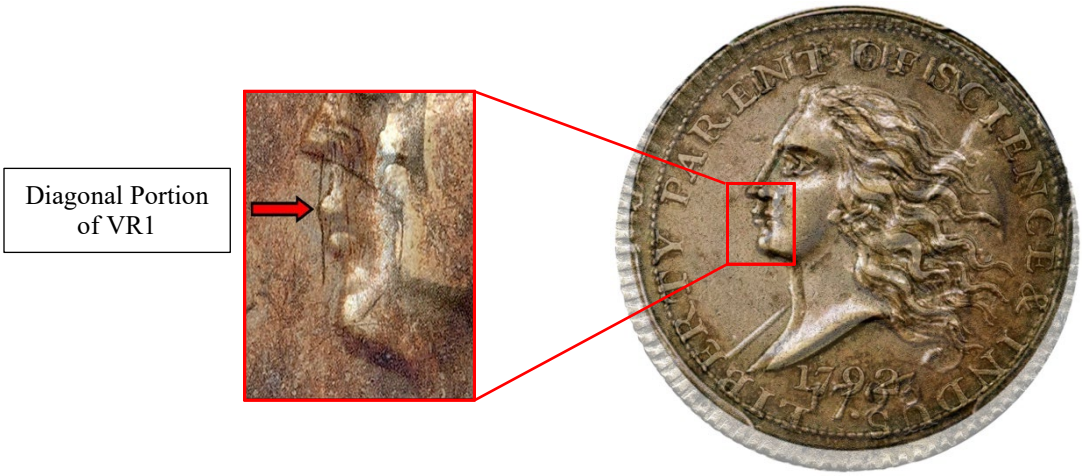


Figure 8. Half cent overlay after Liberty bust shift to diagonal reference point VR1

Figure 9 displays the repositioned Liberty of the half cent compared to that of the disme after the prescribed shifts to VR1.

Figure 9. Liberty bust repositioned lower for the half cent

The third confirmation is shown in Figure 10 where the hair crop of the half cent aligns perfectly with the VR2 designation on the disme, yellow lines, after the bust shift. Given these three confirmations, there is little doubt that the 1792 F15 silver disme was used in some way for the design of the 1793 half cent. As such, we will now reference the silver disme as a Design Work Surface (DWS).[3] We then noticed that by shifting Liberty to the left, there would now be sufficient

[3] Goldbaum Rex. "The engraved pattern 'Mature Head' Design Model: A Window into the Mind of Christian Gobrecht." *Penny-Wise,* Vol. LIV Number 3 (July 2020), pp. 133-141. In this article, Rex Goldbaum introduces the numismatic field to what he references as an "Engraved Design Model" that demonstrates how the new design for the 1843 Mature Head one cent was created by using a proof 1843 Petite Head one cent and why this coin was used. "Surviving documentation of the designing of coinage or pattern issues in this period is nearly nonexistent, in part because such procedures were unique to the styles of individual engravers and generally were kept private even among mint officials." P. 137. This would appear to be the case with the 1792 silver disme too.

surface area to add a possible Pileus (Liberty or Phrygian cap, worn by freed slaves in ancient times) behind her head on the half cent.

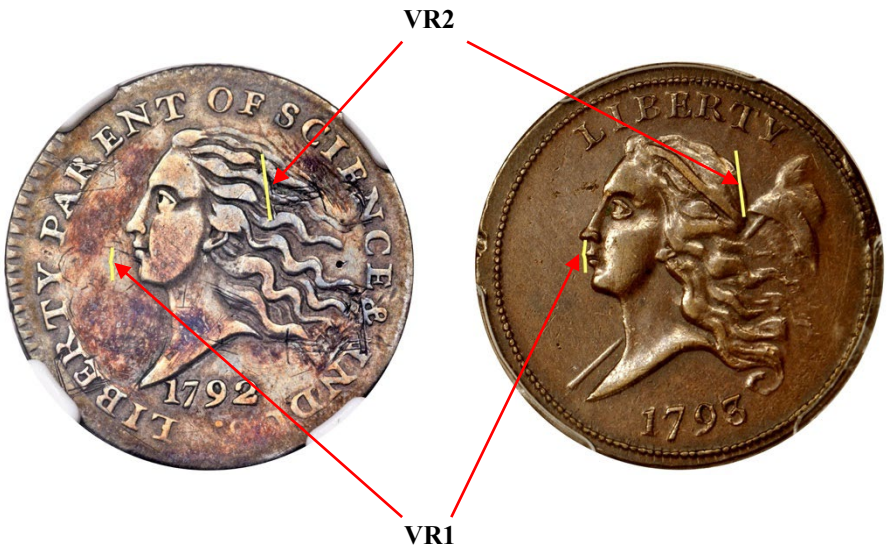


Figure 10. Liberty Vertical Reference Lines #1, bust shift, and #2, hair crop.
Figure 11 confirms that VR1 and VR2 align perfectly after designated bust shift for the 1793 half cents.

Summary Confirmations

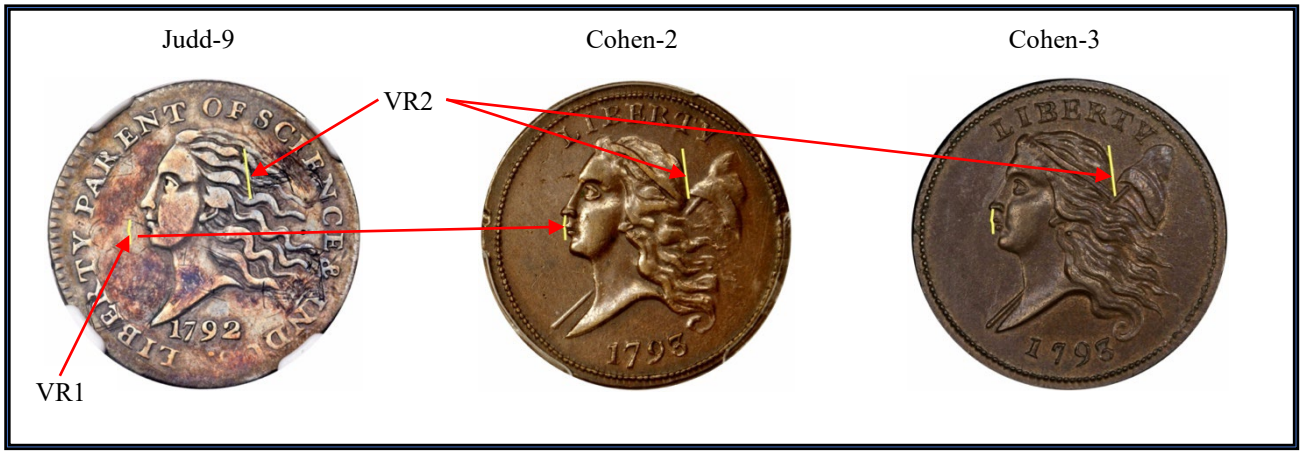


Figure 11. Vertical Reference Lines relative to both major varieties of half cents

Figure 12 delineates obverse yellow target areas for additional analysis on the silver disme that are critically important to a better understanding of this coin's markings. In quadrant 1 (Q1) we were reasonably confident this etch design correlated to the Pileus on the half cent. In quadrant 4, we guessed these markings might represent a measuring gauge or notation, but our confidence in this interpretation was very low. The balance were illegible.

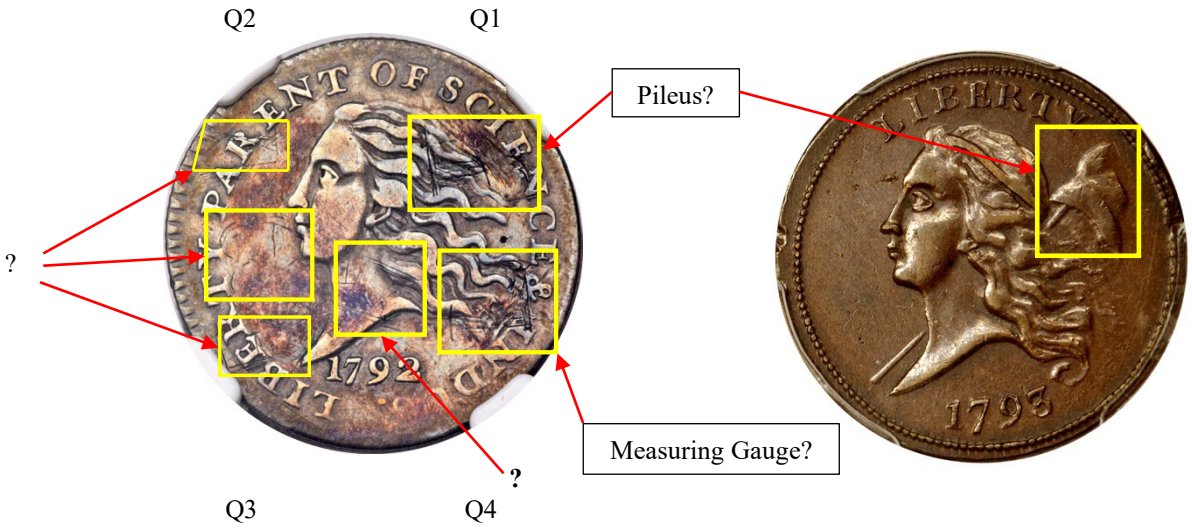


Figure 12. Obverse investigation areas

Reverse Analysis

Figure 13 highlights several areas that were very intriguing to us. Quadrant 3 contained etch marks that we believed represented a potential "W." We thought this might be shorthand for denoting the image of a "wreath," as seen on the reverse of the half cent in Figure 13. In quadrant 4, the etch marks looked as though they could represent a possible "H" that might relate to the "H" in Half of Half Cent. We saw the possibility of hearts that might make this coin into some form of a love token. Quadrant 1 looked to contain what appeared to be an "M" but unfortunately, the upward direction of the left side of the interior "V" would connect to the left leg of the "M" in the wrong area; thus, we were not sure. Finally, there were several other burnished areas where nothing could be seen. What hidden information may be there that might be of importance? There were so many questions that photo imaging analysis could not answer.

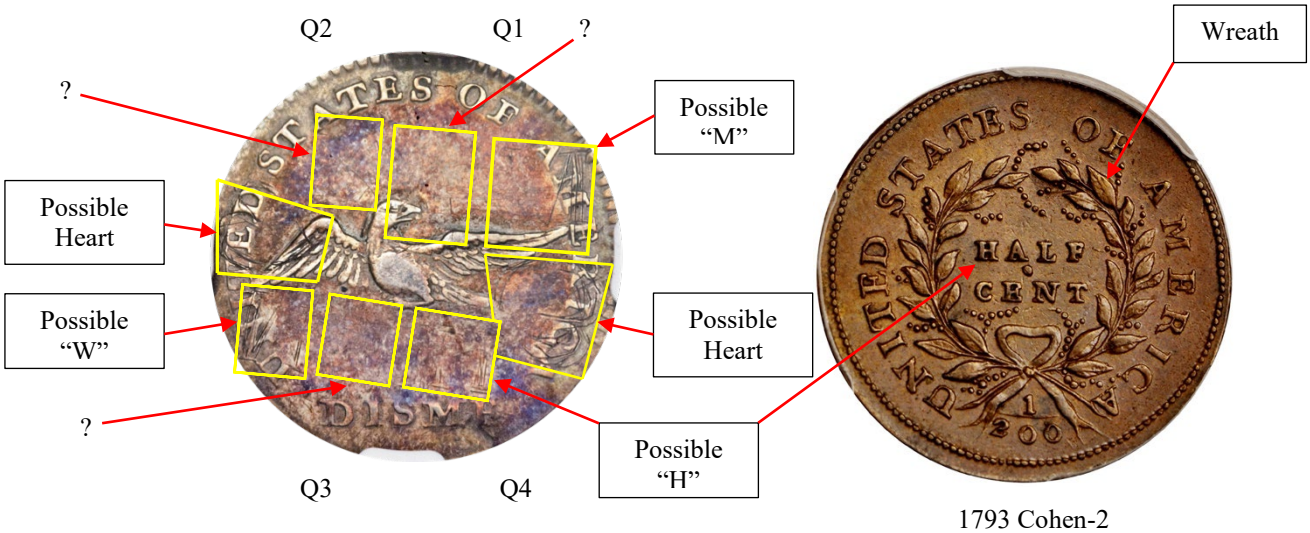


Figure 13. Reverse investigation areas

When we began this journey, we had little idea of where we were going or what we might possibly discover. Our photo imaging studies confirmed we were dealing with a Design Work Surface; however, we had reached the limits of what this type of analysis could unlock. We knew that any further investigations would require we search for, and hopefully find, a method of discovery that would take us beyond that which could be seen. Our search for answers would require the use of scientific instruments that would hopefully unravel and explain these mysteries. If successful, would we be able to answer this key question, **"Was this Judd-9 the DWS used to design the 1793 half cent?"** It was a thrilling prospect! We needed to recover the additional information that Edward Cogan had burnished away in 1863, so that we might prove that this Judd-9 was used to design the 1793 half cent in Figure 14. Our journey was far from done.

Figure 14. Was this Judd-9 the DWS used to design the half cent?

SCIENTIFIC INVESTIGATION

It was serendipity that when discussing this project with my friend, Ron Cline, he said he had a contact at the Los Alamos Testing Laboratory. He was able to link me with Dr. David Teter of the Materials Science and Technology Division. Dr. Teter advised us that the use of their scanning electron microscope (SEM) might reveal the missing information we were seeking. After several discussions took place, administrative protocol prevented us from utilizing this facility. When this attempt failed, I then contacted Fred Holabird, a research colleague, geologist and dear friend, who recommended that we use the SEM at American Assay Laboratories in Reno, Nevada, where he had conducted several previous scientific investigations. When we commenced research studies there, he participated. During our SEM investigations, Dr. Teter proved to be a valuable research consultant.

Phase 1: Scanning Electron Microscopes

American Assay Laboratories

Our first investigation began at American Assay on December 7-8, 2016, and then continued on January 11, 2017, for a total of 25 hours using its Apex Explorer SEM. Salt Anderson conducted the scans which provided excellent close-up images, Figure 15, but our endeavors were only successful in confirming the accuracy of our vertical reference line measurements and nothing more.

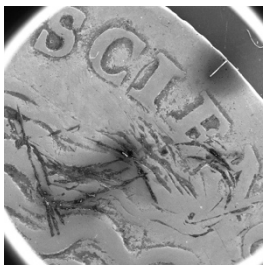
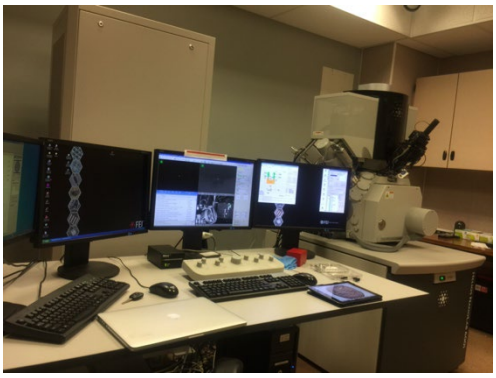
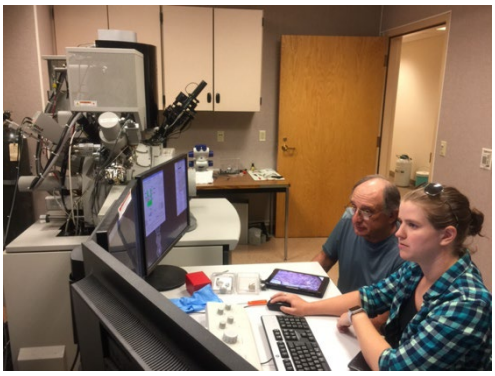


Figure 15. Apex Explorer SEM, Salt Anderson

Colorado School of Mines

I contacted Dr. Teter about the poor results we had achieved, and he recommended that we go to the Colorado School of Mines (MINES) to see Dr. Robert Field, who had been at Los Alamos National Laboratory for nineteen years and then retired to join the research faculty at MINES as, Research Professor, Metallurgical and Materials Engineering. He thought we might be able to recover more information by utilizing its Helios NanoLab 600i, a SEM/FIB dual beam workstation, to conduct SEM analysis and possible electron backscatter diffraction (EBSD). PhD candidate Casey Davis, now Dr. Casey Davis, conducted the research scans, Figure 16.





Casey Davis, Robert Rodriguez

Figure 16. Helios NanoLab 600i

By working with dual beams rather than a single beam SEM, we were hopeful we would achieve better results. We visited MINES twice, July 5-6, and July 25-26, 2017, where we conducted scans

of the coin's surfaces that totaled over 25 hours. Figure 17 shows the chamber and one of the dual beam nozzles.

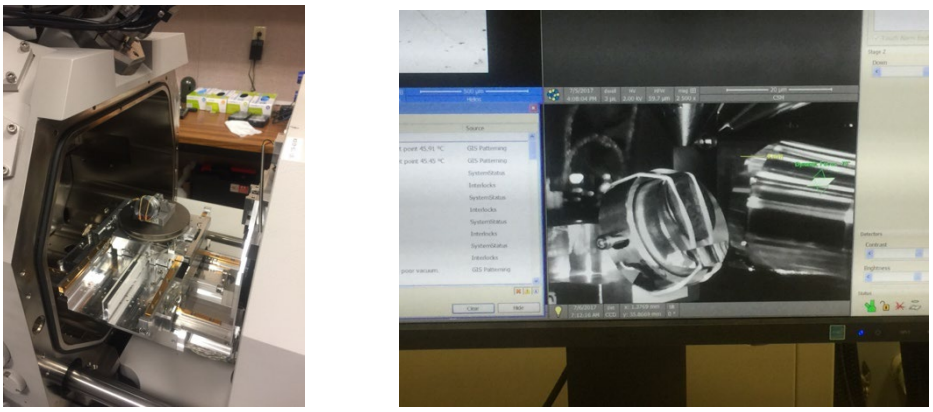


Figure 17. Helios NanoLab 600i scan chamber and dual beams

In the first trip, we scanned several regions of the Judd-9's obverse and reverse, but only close up images of the surface scratches were captured. However, in scanning the reverse in Quadrant 3, the etched letter that we believed to be a "W," proved fruitful. We recovered a small amount of trace information, Figure 18, that confirmed a diagonal downward sloping line for the "W." We were encouraged by this success and returned for a second visit, but no additional confirmation information was recovered. What we learned was that a SEM penetrates to less than 1 micron beneath the surface and, as such, it would not achieve our desired result. Dr. Robert Field said that we had exhausted the capabilities of optical character recognition, so he recommended that we go to the Argonne National Laboratory for its Advanced Photon Source synchrotron facility utilizing X-ray micro-diffraction. This one area of discovery would prove to be important in opening another door for us in our research journey. Dr. Field suggested we contact Dr. Wenjun Liu at the Advanced Photon Source.

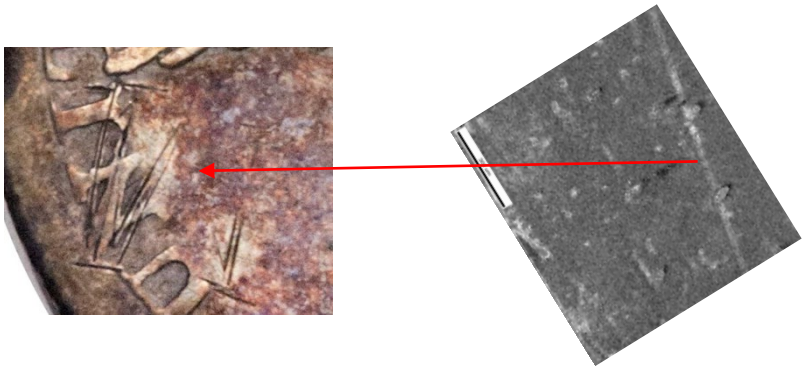


Figure 18. Reverse quadrant 3 possible "W"

Phase 2: Argonne National Laboratory Advanced Photon Source

The Argonne National Laboratory facility is one of the premiere research laboratories in the world that is sponsored by the United States Department of Energy and administered by the University

of Chicago as a multidisciplinary science and engineering research center. It was born out of the University of Chicago's work on the Manhattan Project in the 1940s. Figure 19 provides a sense of the scale of the ANL. In the background is a distant image of the Advanced Photon Source, while the enlarged image of the APS identifies where we conducted our research at beamline 34-ID-E. The dots in the APS parking lot are cars that provide a sense of scale.

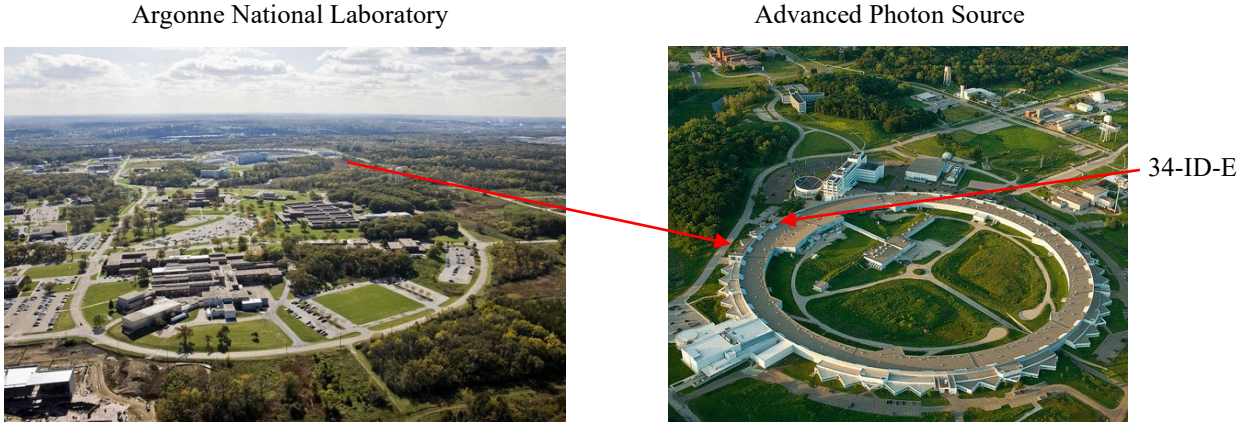


Figure 19. Argonne National Laboratory and the Advanced Photon Source

The APS is a third-generation synchrotron radiation source that is 1104 meters in circumference. It has 35 sectors where more than 70 beamlines can be applied to a broad range of experiments. The facility provides ultra-bright high-energy X-ray beams, about a million times more powerful than X-rays at a doctor's office, to scientists from across the United States for conducting research in nearly every scientific discipline, from materials science to biology, chemistry, environmental, geological, and planetary science, and fundamental physics. The APS is now closed for approximately two years for a major upgrade project that, when completed in 2025, will make it the premiere synchrotron of its type in the world.

When I first contacted Dr. Wenjun Liu about this potential research project, Appendix 1, we had no idea what to expect. Neither Tony nor I were familiar with what the ANL was and what it would require for admission to conduct our research. We had one thing working in our favor, whatever laboratory we visited, this 1792 coin seemed to capture the imagination of those who saw it. That was the case with Dr. Wenjun Liu, and he was encouraged that a small indication of lost information was recovered by electron microscopy, as shown in Figure 18. He also acknowledged this would be a groundbreaking and challenging scientific study that had never been conducted before worldwide.[4] He helped guide us in navigating the process of gaining admittance to the APS. We were beginning a seven-month process which would entail us taking exams and providing a $2 million liability insurance policy for a project that had never been done before in the world, since we were not sponsored by any institution in the Argonne database. Fortunately,

[4] There have been other investigations using X-ray micro-diffraction but nothing in comparison to what we would be attempting. For example, Andrew Bearnot and Ashley Greene, "Study and Comparison of Coins by X-ray Diffraction (XRD); Preliminary findings," Brown University (2015), investigated several ancient and modern coins using one-hour scans multiple times to examine micro-structural composition and atomic structure.

we were able to locate and then purchase the appropriate insurance through my auto racing insurance broker, Burnham WGB Insurance Solutions.

This project was entering a new area of scientific antiquities investigation that is known as Cultural Heritage Research. Prior to our project, in 2016 the APS used its high-tech X-rays to investigate the molecular structure inside the bones of a Tyrannosaurs Rex without having to cut open the fossil. Then in 2017, this high-powered instrument was used to examine the interior of an 1,800-year-old mummy from Northwestern University without having to remove the linen from the wrapped remains. Carbonized scrolls from Herculaneum were studied at the European Synchrotron Radiation Facility in Grenoble, France. This project was the subject of an April 1, 2018, *60-Minutes* feature presentation. Finally, if our research project was accepted, it would become the first in the world to utilize synchrotron-based μ-XRD technique upon a coin, a 1792 silver disme, to hopefully unlock its mysteries by capturing images of what use to be on the surface but from its interior sub-surface metal lattice. We were told that no museum would take the risk of subjecting an extremely valuable and rare coin to this new scientific investigation technique.

Our research proposal was approved and received a score of 1.75, on a scale of 1-5 with 1 being best. We were awarded four shifts that totaled 32 hours. We had no idea how good a score this was until we were told that fewer than 40% of all proposed projects receive a score at this level. Prior to commencing testing, an experimental test was conducted upon a 1795 half disme to determine whether there might be any potential negative effects from μ-XRD and there were none.

Figure 20 is of our arrival at the APS for our first day of μ-XRD analysis on February 27, 2018. We were unsure of what to expect, but we were truly excited to be afforded this opportunity to conduct groundbreaking research at the APS. Until one enters the interiors of the synchrotron, its immensity is truly indescribable.

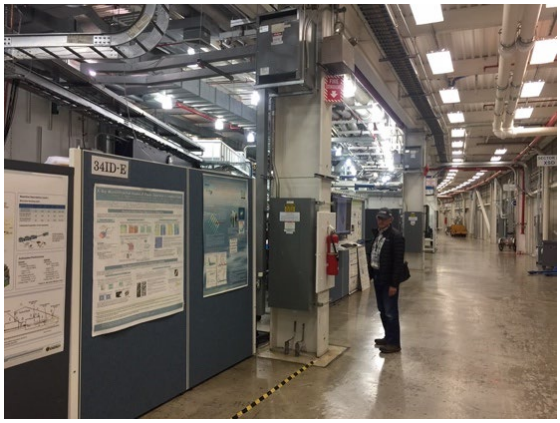


Figure 20. Our arrival for our first day at the APS, February 27, 2018

Figure 21 provides a sense of the interior size of APS experimental hall and an example of the magnet array that accelerates high-speed electrons circulating in synchrotron storage rings to produce intense X-rays for beamlines around ring.

Experimental Hall

Magnet Array

Figure 21. Inside the APS

A "new" scientific investigation methodology: X-ray micro-diffraction

X-ray micro-diffraction is a technique that utilizes an extremely narrow X-ray beam to perform highly localized studies of crystalline materials. At beamline 34-ID-E of the APS, a diffraction microscopy technique is used to examine the crystal structures of materials in all three dimensions with sub-micron spatial resolution. The physics behind this is Bragg diffraction that gives the angles for coherent scattering of X-ray waves from a crystal lattice of material. By measuring the distortions and/or strains of metal crystal lattice, an image can be generated without harm to the object being investigated. Figure 22 is an example of the subsurface analytical process whereby various scan characteristics are measured. For the examinations upon numismatic coins, X-ray diffraction measurement was performed at every local point. Each analyzed pixel produces a powder diffraction pattern, providing lattice strain information about the local material as deep as 50 microns. Millions of individual data points are analyzed in this fashion. This collected data is then processed through high-speed computers that can generate an image of the surface's past condition based on the deformation of the subsurface metal lattice.

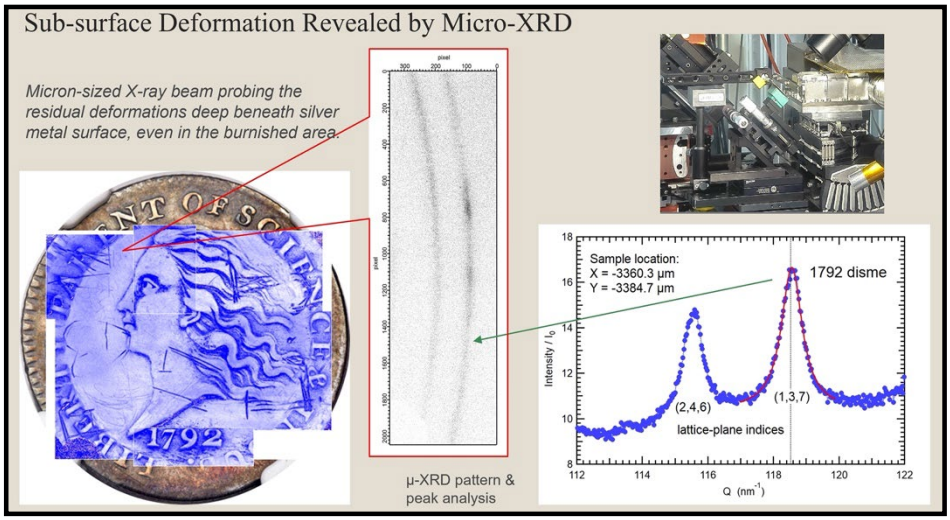


Figure 22. Subsurface Deformation Revealed

It is both science and educated judgment to achieve positive μ-XRD results. IfThe type of beam can also affect the quality of the outcome. When initially discussing the project with Dr. Wenjun Liu, he suggested that Laue diffraction mapping with a polychromatic X-ray beam could potentially be an effective method for capturing residual deformations deep beneath the surface in the burnished area. However, after conducting several trial tests, he opted to use monochromatic X-rays for more precise measurements of lattice deformation. Furthermore, an optimized X-ray energy was chosen based on its penetration power into the silver material. If the energy power is too low, the X-ray image will contain information from both the current and the original surfaces; however, if the beam penetrates too deeply, then there will be too much noise coming from the deeper materials of the coin that prevents a successful recapture of the desired information.[5]

[5] Liu, Wenjun and Ice, Gene. "X-ray Laue diffraction microscopy in 3D at the Advanced Photon Source". Stain and Dislocation Gradients from Diffraction: Spatially-resolved Local Structure and Defects. Imperial College Press, 2014, pp. 53-81.

Research Team

The APS research team, Figure 22, consisted of three physicists, Dr. Wenjun Liu, Dr. Jon Tischler, Group Leader, and Dr. Ruqing Xu. This team would bring their combined experience to this project. Dr. Liu was our primary contact and advisor. Additionally, we had the enthusiastic support of the Argonne National Laboratory staff.

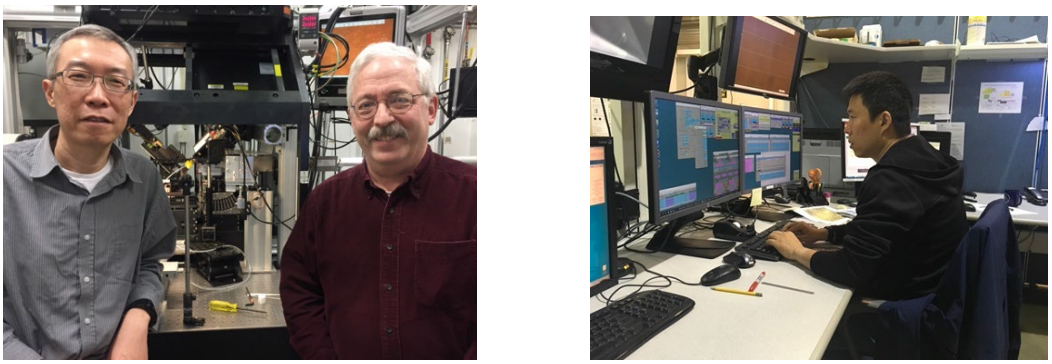


Figure 23. From left, Dr. Wenjun Liu, Dr. Jon Tischler and Dr. Ruqing Xu

Scanning the Reverse

VISIT 1: Preparing for the first scan

Our research would eventually entail five visits to the APS between February 28, 2018, and July 28, 2020, involving nearly 600 hours of μ-XRD analysis in 16 scans of varying duration. Because Tony and I were new to this experience, we were unsure as to how to prepare for our first visit. After that, our knowledge and experience grew so that we began to create detailed scan templates in preparation of where we should focus the scans and eventually, we became good at estimating the required scan times for each area. As the scans proceeded, additional insights were gained, and adjustments were made to the original template target regions to achieve better outcomes.

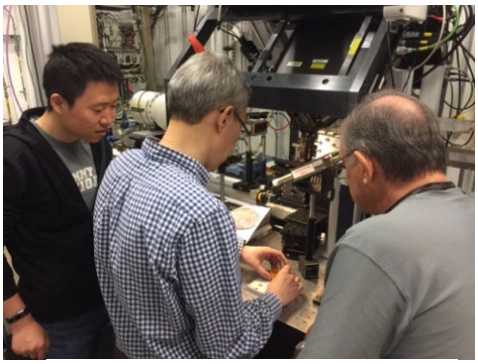
Figure 24 is the 34-ID-E beamline experimental hutch where the X-ray scanning occurred. When the scan was ready to begin, the hutch door was shut and locked until the scan was finished or terminated so that the sample coin could be shifted for the next investigation.

Figure 24. 34-ID-E beamline experimental hutch

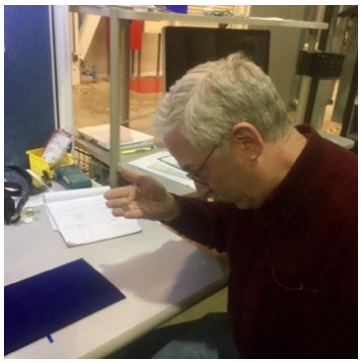
Tony and I believed that the 32 hours awarded for this project was a huge amount of time, but we were in for a big surprise. Prior to the first scan, a considerable amount of discussion ensued as to where we should target the first scan. Because the MINES SEM had captured a small portion of the diagonal line in the quadrant 3 reverse area that indicated a potential "W" had been etched, Figure 18, the team selected this area for the first scan. Since this would be the first ever μ-XRD scan of a coin attempting to capture a subsurface lattice image requiring extended X-ray exposures, as an added layer of protection, it was encased in a helium atmosphere. This preparation process is depicted in Figure 25.

Tony Lopez, Wenjun Liu,
Robert Rodriguez

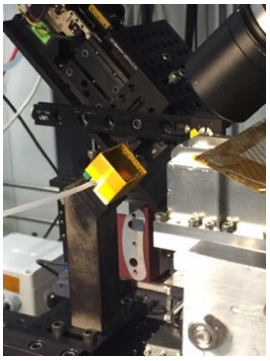
Ruqing Xu, Wenjun Liu,
Jon Tischler



Ruqing Xu, Wenjun Liu,
Robert Rodriguez



Jon Tischler

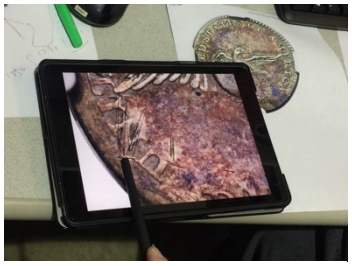


Helium atmosphere
container

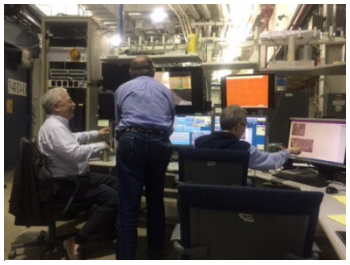
Figure 25. Preparing for the first μ-XRD scan

The orange computer screen in the background of Figure 26 (top right image) is an optical microscope used to identify and detail the exact location for the scan and then to monitor its progress. Measurements were conducted in microns at a very high levels of magnification. This process was initially assisted by iPad coin images for the scan target region, as shown in Figure 26.

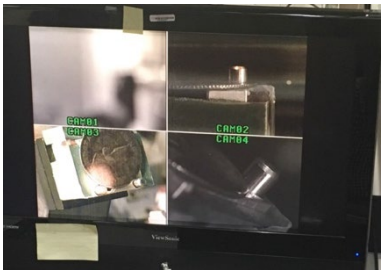
iPad



iPad

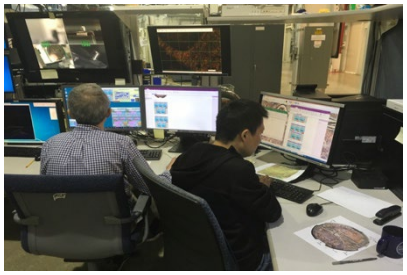


Jon Tischler, Robert Rodriguez, Wenjun Liu



Cameras viewing sample at different angles

Tony Lopez



Wenjun Liu and Ruqing Xu

Figure 26. Scan V1S1 targeting process

For identification purposes, each of the scans will be designated with an APS visit number "V" and the scan number "S" so that Visit 1, Scan 1, is identified as V1S1.

VISIT 1: February 28-March 3, 2018

V1S1

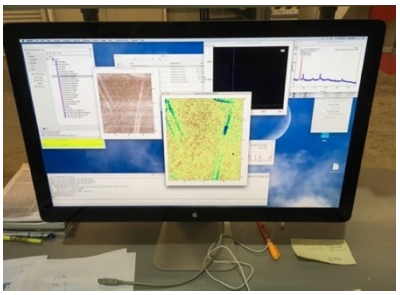
For the first scan the decision was made to target the reverse area in quadrant 3, Figure 27, a 3 mm square. The enlarged image provides a better view of the target area. To cover this area, 20-micron spacing was used for the scan. A beam energy level of 20.2 keV (thousands of electron volts) was selected by the APS team. At this energy level, it was estimated a depth of up to approximately 50-microns would be attained. Depending upon the depth of the subsurface metal lattice deformation, the estimated depth might be too shallow or too deep; therefore, if this occurred, an image of the engraved features would not be captured. After nearly twenty-five hours of scanning, we were about to see whether we had a success or failure. While waiting, a team of researchers visited the beamline. Leading them was Dr. Dennis Mills, Deputy Associate Laboratory Director for Photon Sciences. He asked how the scan was proceeding and Wenjun said we were about to find out. While waiting, I said to Dr. Mills that I thought I could sum up what the Argonne Laboratory stood for in three words and then said, "science and industry." He responded this was exactly correct. With that, I showed him the legend on the coin, "LIBERTY PARENT OF SCIENCE AND INDUSTRY." All were amazed. After that encounter, this small coin captured the attention of many at the laboratory, including X-ray Science Division Director Dr. Johnathan Lang. Shortly thereafter, the first successful μ-XRD scan image of a coin in the world was captured, as shown in Figure 28. In a review of several papers where XRD and μ-XRD techniques have been used to investigate coins, their focus has typically been on morphological and chemical

compositions, as well as on micro-chemical structures.[6] However, none went to the extent of attempting to recover a subsurface metal lattice image and their scan times were very short, an hour or so, by comparison to this project.

First successful µ-XRD coin image in the world

Figure 27. Target scan area

Enlarged V1S1 target scan area



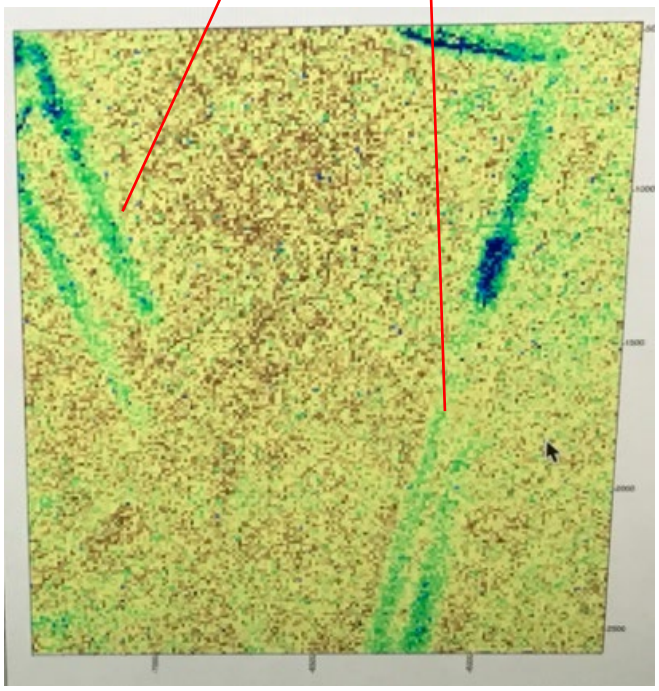
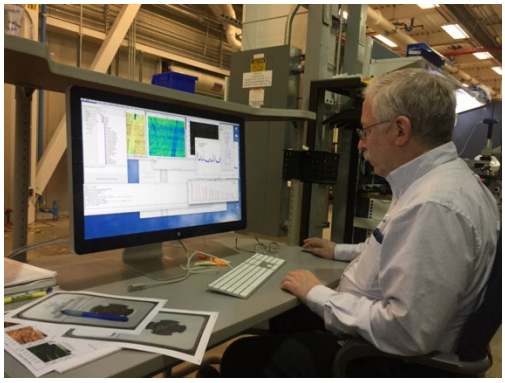


Figure 28: V1S1 first successful µ-XRD coin image in the world

[6] Serra, Antonio et al. "Unusual coin from the Parabita hoard: combined use of surface and micro-analytical techniques for its characterization." *Journal of Cultural Heritage* 11 (2010), pp. 233-238.

In Figure 29 the APS team evaluates the scan result. And with this, the 32 hours of awarded laboratory time came to an end.

Ruqing Xu, Wenjun Liu and Jon Tischler

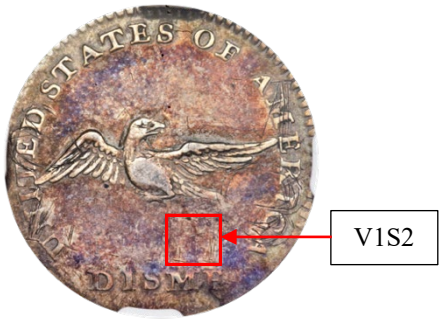


Jon Tischler

Figure 29. Evaluating V1S1

V1S2

Given this successful outcome, Wenjun asked if we were available for another couple of days since there was an opening in the beamline schedule which we gladly accepted. In Figure 30, the second scan, V1S2, targeted an area where the etches might represent an "H." Tony and I had thought this could be shorthand for Half in Half Cent. After thirty-eight hours of scanning, Figure 30 shows that we did not capture an "H."



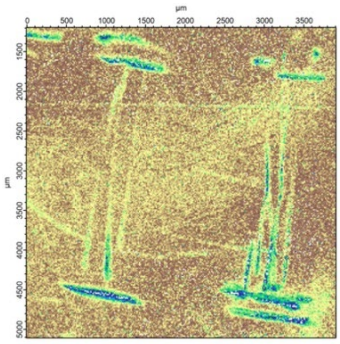


Figure 30. V1S2

Both of us were confused by this outcome since for nearly two years, we thought in terms of letters. On our return flight to Los Angeles, it dawned on us that these etches represented Roman numerals. Thus, we needed to scan an additional area to determine exactly what we were seeing and its meaning. With the length of this scan, we gained a deeper appreciation of what it might take to complete the various scan regions for the entire coin.

VISIT 2: June 5-11, 2018

V2S1. June 5-6

Our second proposal envisioned scanning an area between the captured "W" and the Roman numerals. Figure 31 shows that the V2S1 target scan area to be slightly more than twice the area of V1S2. With 20-micron spacing and using 18.8 keV, the estimated scan would require 27 hours to complete. However, initial results showed this new frequency level was not as effective as the previous, so the scan was stopped, and we returned to 20.2 keV. We were not slowed down much because of the wider spacing. Despite two beamline interruptions, the scan area was covered in just under 35 hours. We fully expected to capture another Roman numeral one and then a diagonal division sign so that we would have "1/2," which would be a shorthand abbreviation of the "1/200" used on the half cent for its denomination. A Roman numeral "I" was captured, as shown in Figure 32, but a diagonal division sign was not. Instead, two etch marks appeared at the top; however, the bottom portion was not recovered since beam intensity was lost on about 20% of the scan due to synchrotron storage ring glitches. A colon sign was a high probability possibility, since this was an alternative designation for division used during the 18th century. Confirmation of a possible colon sign would have to wait for another scan opportunity to confirm its existence. Should this be the case, we would have all the design elements for the reverse of the 1793 half cent.

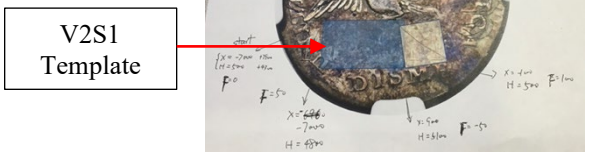


Figure 31. V2S1 template target area

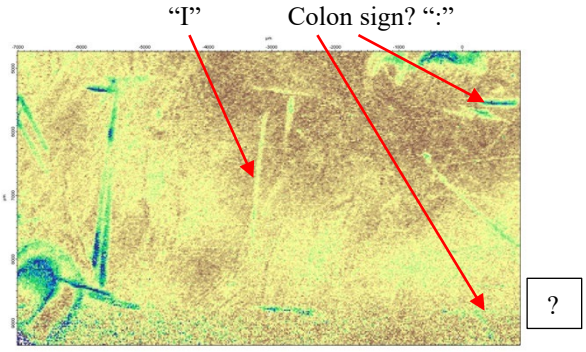


Figure 32. V2S1 capture "I" and possible ":"

V2S2. June 7-9

Figure 33. V2S2 scan template, blue highlighted area, would require about 68 hours to complete. The scan result, large red rectangle area, shows both the visible and non-visible (subsurface residual) information. The non-visible portion is located to the left of the interior vertical red line. We were not sure that the partially viewable letter represented an "M" since the interior left upward sloping line was at an incorrect angle to form an "M." The scan revealed the engraver's error correction of this angle which proved that what we thought to be an "M" was actually an "M." At the far left, an "E" was recovered. We were unsure as to what these letters might represent. Between the two of them, given the severity of the burnishing damage that was so deep, we were unable to recover any additional information from the subsurface metal lattice.

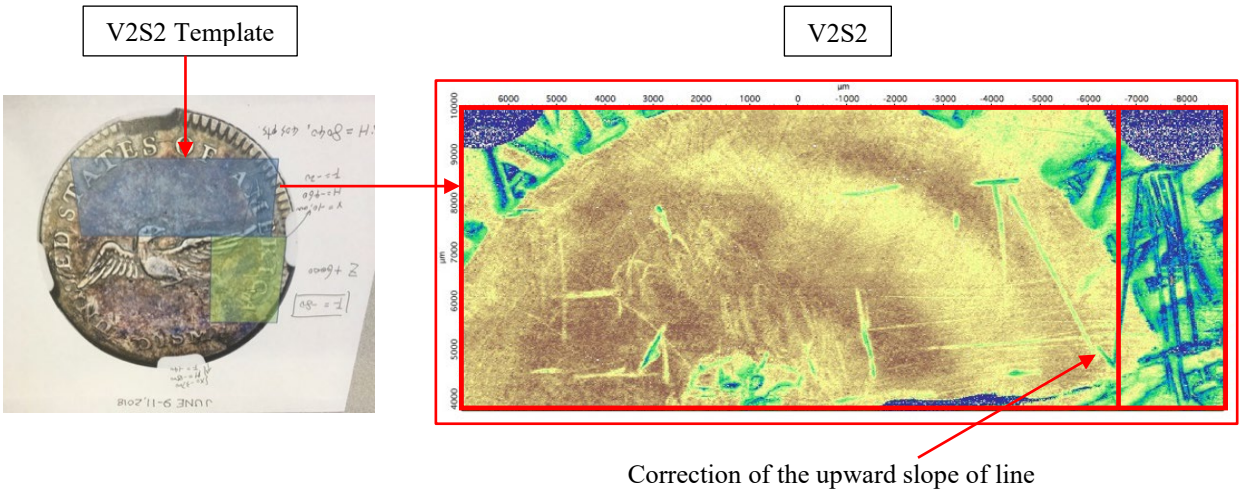


Figure 33. V2S2 recapture of letters

V2S3. June 9-11

After 36 hours V2S3, Figure 34, recaptured a heart. With this recovery, we thought this coin might also represent a love token or a "A permanent record of his affection…"[7] that were very popular during the 18th and 19th centuries. Given this new information, we thought the area between the two letters might have also contained a heart. As to who or what these letters might represent, we will defer this assessment for the "Educated Speculation" section.

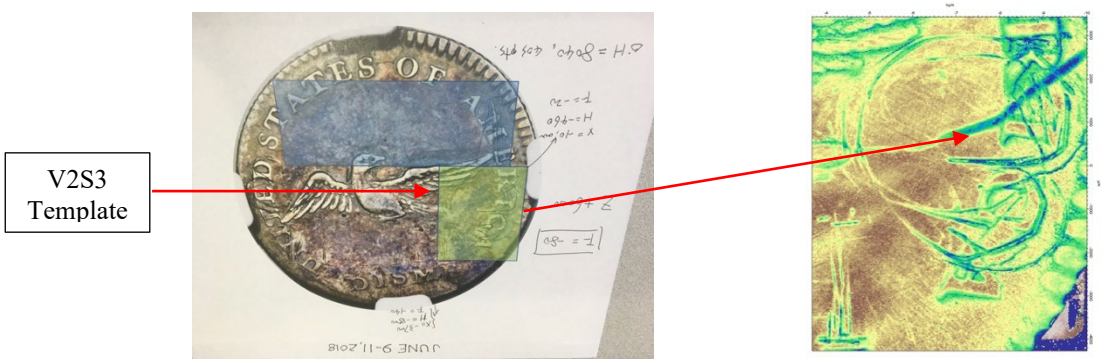
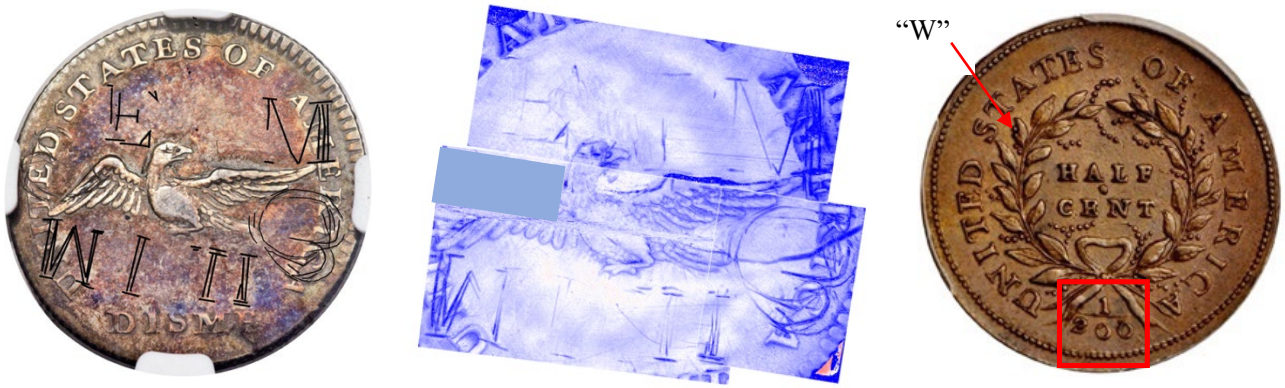


Figure 34. V2S3 heart image

Figure 35 provides a nearly completed reverse scan of the newly recovered information and our artistic representation of the scan. We believe the "W" is shorthand for the wreath, as shown on the 1793 half cent, and the likelihood of "I : II" represents an abbreviation of the "1/200" used on the half cent for its denomination.

[7] Millmore, Bridget. "Love Tokens: Engraved Coins, Emotions and the Poor." University of Brighton, thesis for the degree of Doctor of Philosophy, February 2015, 14.



Artistic representation "W" Likely "I : II" 1793 Half Cent "1/200"

Figure 35. Nearly completed reverse imaging

Scanning the Obverse

With the reverse nearly completed, another beam time proposal was submitted, and we received an approval for 168 hours. We could now proceed with the deciphering of the obverse etch marks which made little sense to us. However, we were quite confident Quadrant 1 of Figure 37 contained what we believed to be a Pileus. In visit 3, we would evaluate several areas that we estimated would require approximately 148 hours of scanning. During all our visits, just one guest was able to join us to witness the μ-XRD process, Len Augsburger, an expert on 1792 coinage and co-author, *1792: Birth of a Nation's Coinage*. Dallas, TX: Ivy Press, Inc., 2017. Figure 36. After that, Covid-19 prevented any other visitations.

Figure 36. Len Augsburger witnessing the μ-XRD process

VISIT 3: November 13-21, 2018

Figure 37 is the scan template we initially proposed for the third visit. The difference between the awarded 168 hours and our estimate of 148 hours of scanning reflects what is required to set-up each scan and allow for any beamline interruptions.

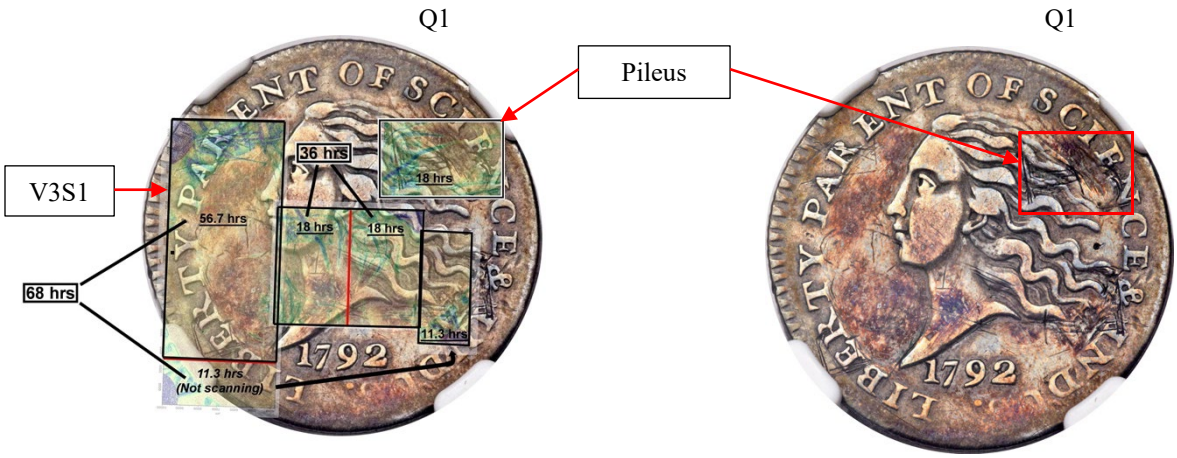


Figure 37. Original scan template estimated time-148 hours, available time-168 hours

After discussions with the APS team, we adjusted the scan template and then proceeded with V3S1 in Figure 37. We targeted this area since it might show a relationship between it and what we were unable to recover in the upper central reverse of V2S2, Figure 33, between the "E" and "M" because of the severity of the damage to the subsurface metal lattice. Might we discover something similar? During this process, we were able to improve our scan productivity so that we now estimated we could cover a greater area but in the same estimated time of 148 hours.
V3S1. November 13, 2018.

Figure 38. After 68 hours V3S1 confirmed we had "E ♡ M" and, in our opinion, this configuration was what was most likely portrayed on the reverse in the area between the "E" and "M" in Figure 33. The love token theme was established for both sides of the coin. Obviously, the person who engraved this sentiment displayed a strong loving feeling for "M."

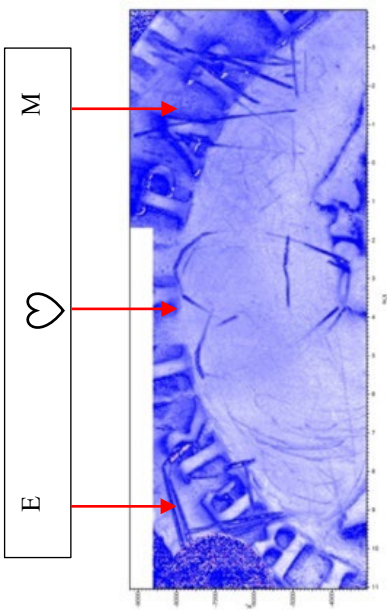


Figure 38. V3S1 "E ♡ M" obverse

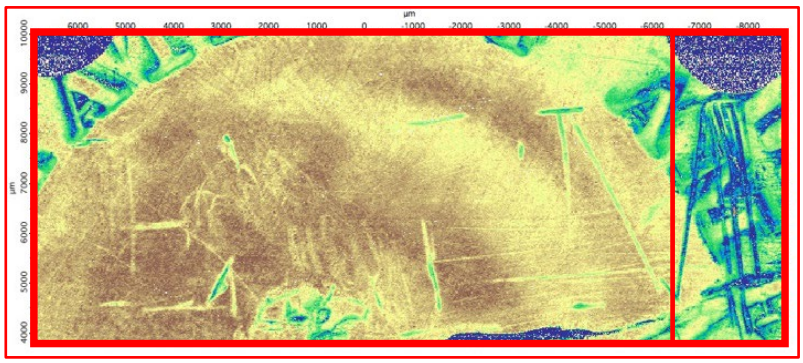
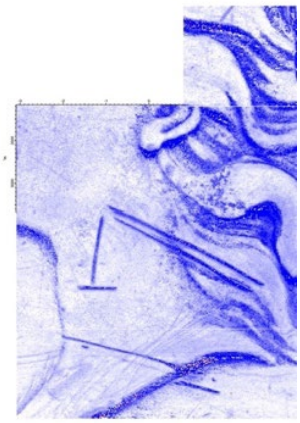


Figure 33. V2S2 reverse

V3S2. November 16, 2018

We captured what appeared to be a “17” in Figure 39, but we do not know what it means. From our earliest photo imaging, we had various theories about what the marks might portray, but we never saw a “17.” This became a combination scan whereby it led into scan V3S3.

Scan V3S2



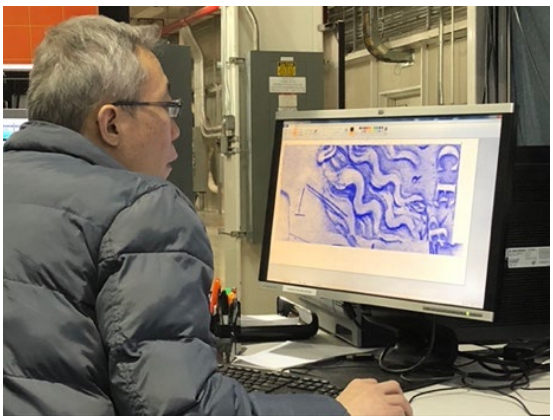


Figure 39. “17” and Wenjun analyzing scan

V3S3. November 21, 2018. Breakthrough! "L • J"

Figure 40. After nearly 80 hours of scanning areas V3S2 and V3S3, V3S3's image recapture came as a complete surprise. For over two years, we were highly confident that we had a Pileus in quadrant 1 of Figure 40. When Wenjun conveyed the discovery of "L • J" to us on our return trip home, we were at a complete loss as to what the abbreviation might mean since our thinking had centered on an image and not letters. Upon my return, I was at dinner the following night with my cousins David and Gina McEwen, who were very interested in the project and had been following its progress. Upon her viewing this scan and learning that we were confused by what these letters meant, she immediately responded, "Could they mean Liberty and Justice?" I was shocked that Tony and I had not made this connection. It made perfect sense.

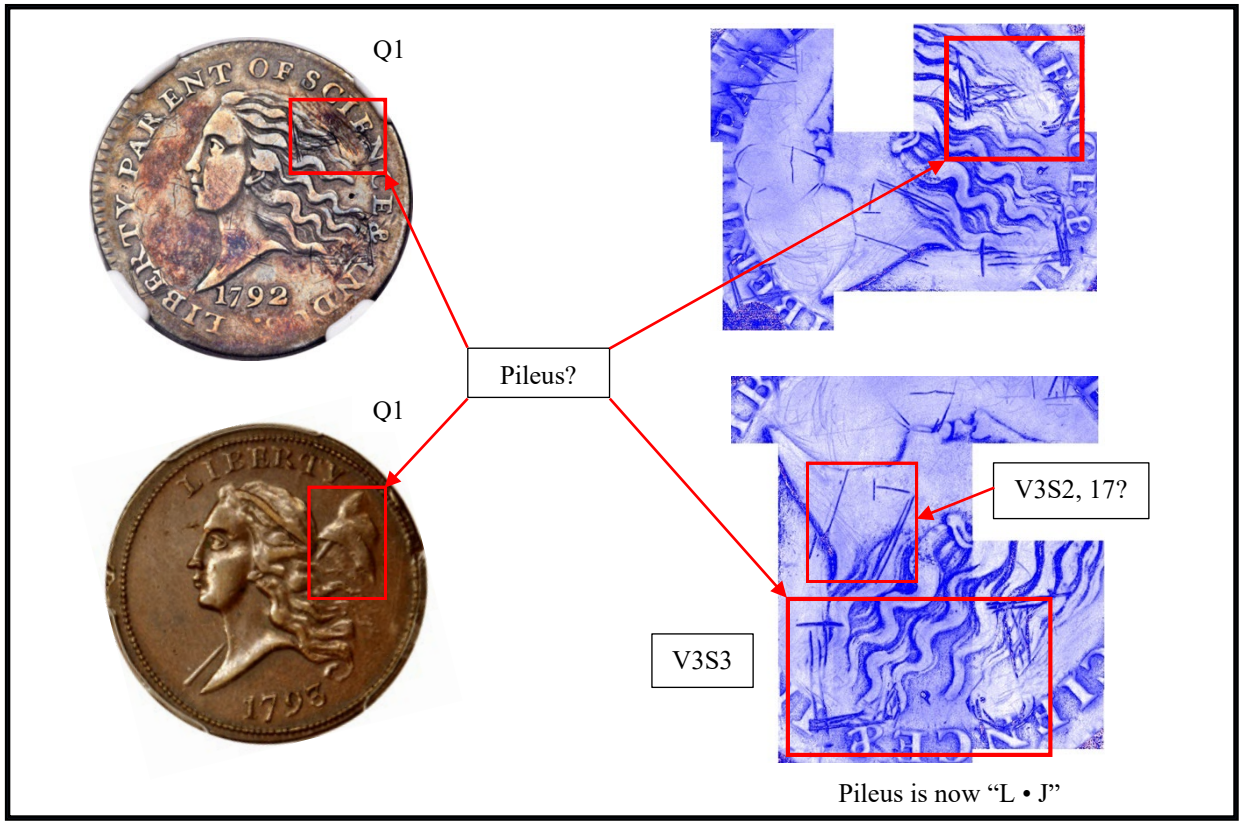


Figure 40. Discovering "L • J"

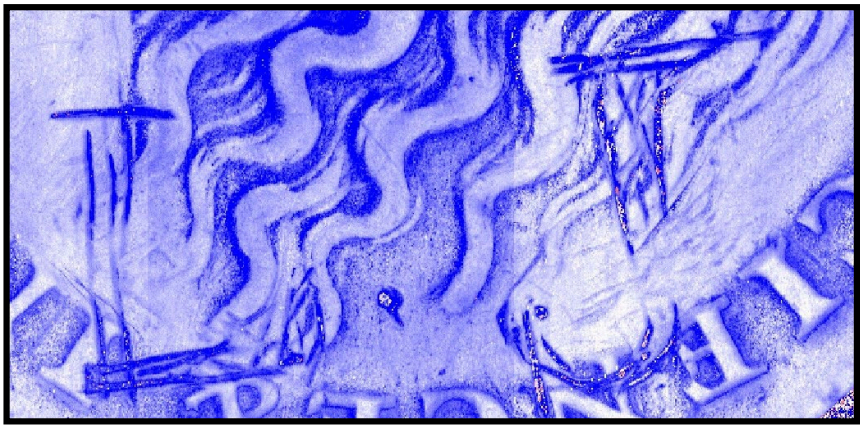


Figure 41. Enlarged "L • J"

Potential Link to 1783 Nova Constellatio Coinage

Our thinking immediately shifted to the historic 1783 Nova Constellatio pattern coinage, which were a national decimal coinage proposal under the direction of Robert Morris, Superintendent of Finance for the Confederation. They are among the first coinage creations to be based upon a decimal system and are of immense historical importance. The legend, "Libertas • Justitia" is very close to that intended on the disme but using the English equivalent of "Liberty • Justice." Figure 42 displays two examples of these rare creations, a BIT and a MARK, with the denominations of 100 and 1000, respectively. Of particular importance are the font styles used on both of these coins, which are compared in Figure 43. Note the similarity of the "L • J" fonts on the silver disme versus those used on these Nova Constellatio patterns. When this comparison was shown to Joel J. Orosz, co-author, *1792: Birth of a Nation's Coinage.* Dallas, TX: Ivy Press, Inc., 2017, he wrote, "This potential relationship of your disme with the 1783 coinage is extremely interesting. Your L and J interpretation as Liberty and Justice sounds plausible to me."[8] And "The connection you have found between the coinage of 1792 and 1783 is truly significant…"[9] While his co-author, Leonard Augsburger wrote, "The inclusion of Liberty and Justice is important. We know this echoes the Morris patterns (Nova Constellatios) but it also echoes the federal coinage legislation.*"*[10] (See *1792: Birth of a Nation's Coinage,* p.28) Adam Eckfeldt would likely have been aware of these since his father, John Jacob Eckfeldt, in February 1783, was paid to forge three pairs of dies and then another two in April.[11]

1783 BIT 100 1783 Mark 1000

Figure 42. 1783 Nova Constellatio\

[8] Joel J. Orosz, e-mail message, December 28, 2018.
[9] Ibid. January 3, 2019.
[10] Leonard Augsburger, e-mail message, June 29, 2023.
[11] John Catanzariti and others, editor, *The Papers of Robert Morris, 1781-84, Volume 7: November 1,1782-May 4, 1783.* (Pittsburg, Pa.: University of Pittsburgh Press, 1988), 740.

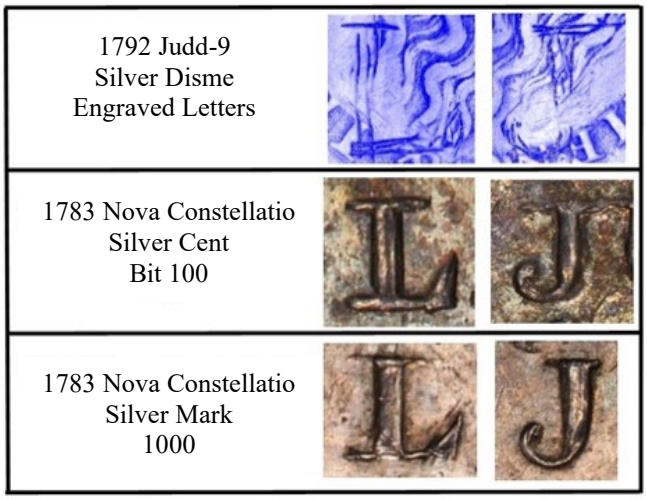


Figure 43. Font styles

VISIT 4: February 12-18, 2019

The goal of this visit was to rescan a portion of V2S1, Figure 32, where approximately 20% of the scan failed to occur because of a beamline interruption, along with completing the reverse imaging. After 43 hours, V4S1, Figure 44, captured the bottom portion of the colon, so we now had confirmation of "I : II." With the completion of the 37-hour V4S2 scan, the reverse imaging was finished. We then shifted to the obverse to complete its imaging.

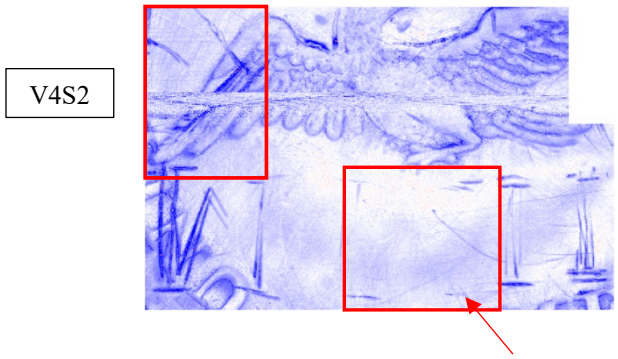


Figure 44. V4S1 recapture bottom of colon sign

Figure 45. V4S3 and V4S4 required scans of 15 hours and 16 hours, respectively, to complete the obverse imaging. We were hopeful the scan of Liberty's face in V4S4 might provide additional information or insight about the perplexing "17" captured by V3S2, Figure 39. Unfortunately, nothing more was discovered, but these scans did complete the total imaging of the obverse.

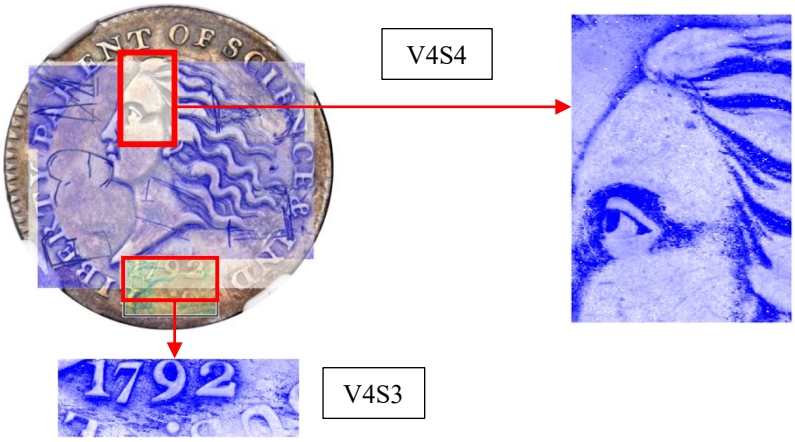


Figure 45. Completing the obverse image

After the disme scans, we then shifted to a Judd-5 Birch Cent where the 12-hour scan of V4S5 is discussed in Appendix 5. A total of 123 hours was required to complete all five scans.

VISIT 5: July 21-28, 2020

On January 13, 2020, the Judd-9a was acquired for The Resolute Americana Collection, Figure 46, since we believed it was likely used in the design process. With its acquisition, this would mark the first recorded instance where all three silver dismes resided in one collection. Most importantly, this would allow for a complete investigation of the 1792 silver dismes with surface "issues."

Figure 46. Judd-9a

We presented a new proposal for a fifth visit, and we were awarded 100 hours to cover the scan template's three designated areas identified in Figure 47 lower left. Scan V5S1 targeted the area above the date and the date. We speculated this area might contain a design element above the date, very similar to those seen on some 1793 large cents that have a leaf design. After capturing the date, and since we were not finding any indication of a design element, the 33-hour scan was terminated after 28 hours. V5S2 focused on the Judd-9a surface etches since they were located in a similar area to that of the VR1 on the Judd-9. We were unable to recover any images because the subsurface lattice had been impaired by the severity of the surface adjustments, so after nearly 34 hours, the scan was terminated. For the third and final scan, we hoped that V5S3 might uncover some additional information about the mysterious "17" on V3S2, but we found none.

The date recapture of V5S1 presented a stunning image to us all. (View enlarged image Figure 2) This is the first time it had been seen since 1792. The date's removal was clearly done for a purpose, and we believe it was to experiment with date placement on the half cent. We also noticed

there was no indication of VR2 and, as such, the date shifting was likely considered at an earlier stage of the design phase. The diameters of both the disme and the half cent are virtually identical at 22 mm, so a 1:1 ratio was easily used to transfer the VR1 and VR2 reference lines to the half cent. As a result of this investigation, we are of the opinion this Judd-9a was also used in conjunction with the Judd-9, as part of the 1793 half cent design process. In light of these new insights, we amended our thinking about the obverse design flow.

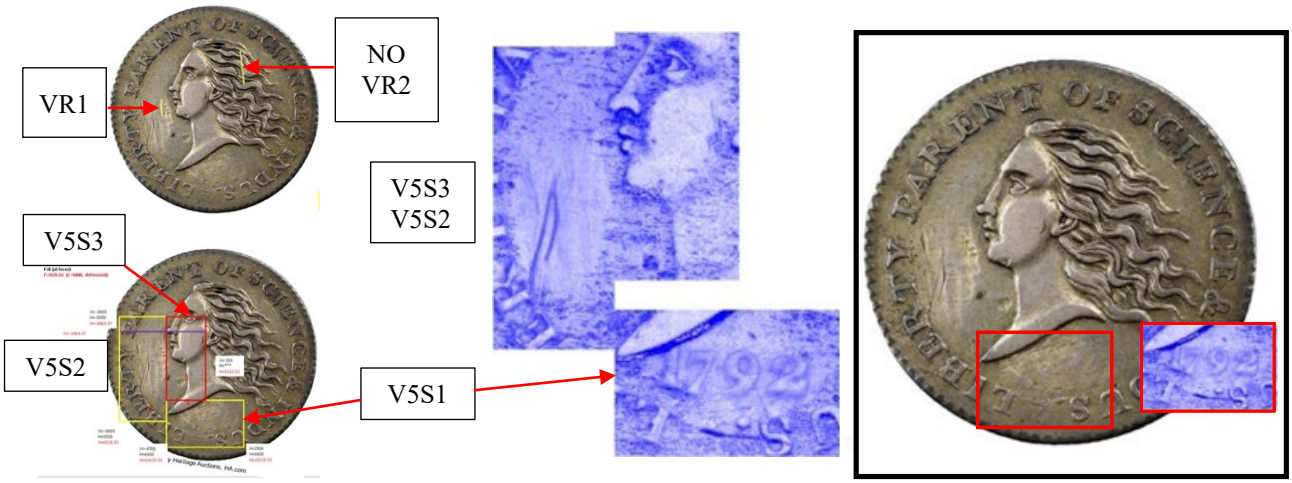


Figure 47. Judd-9a scans

Obverse Design Flow

Figure 49 illustrates our view of what we believe was the design flow for the 1793 half cent. However, it evolved as we gained new insights. As a result of the "L • J" discovery, our thinking progressed so that Phase 2 became "Liberty • Justice;" however, upon additional analysis of the "J" from V3S3, both Ruqing and I noticed there seemed to be two parallel vertical lines above the "J." When viewing the photo image on the left in Figure 48, it looked as though there was only one vertical line that we delineated as VR2 versus the two seen in the right scan image. As such, we realized the "J" or Justice was to be eliminated because of the addition of the hair crop designation line was not on the Judd-9a. Because of this new insight gained from the Judd-9a scans, we added Phase 3 to reflect a lowering of the date. In Phase 4, by shifting the position of Liberty to the left and downward, cropping her hair and then shortening the legend to read "Liberty," there was now room for the addition of a Pileus. Phases 5 and 6 display the final design applied to both obverse varieties of 1793 half cents.

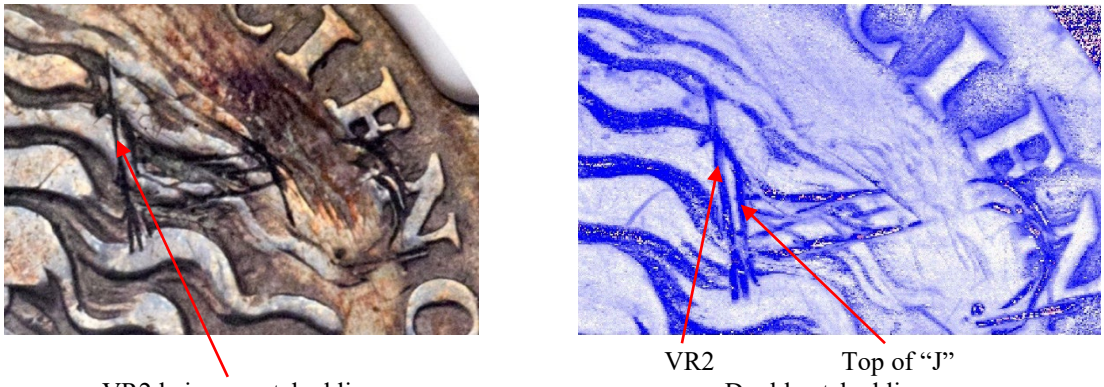


Figure 48. "J" image analysis from V3S3

Figure 49. Obverse Design Flow

Reverse Design

Figure 50 clearly shows how all the design work surface elements on the reverse of the silver disme came together on the 1793 half cent reverse. The "W" is shorthand for the "wreath" while "I : II" would be a shorthand abbreviation of the "1/200" used on the half cent for its denomination, with the legend already in place.

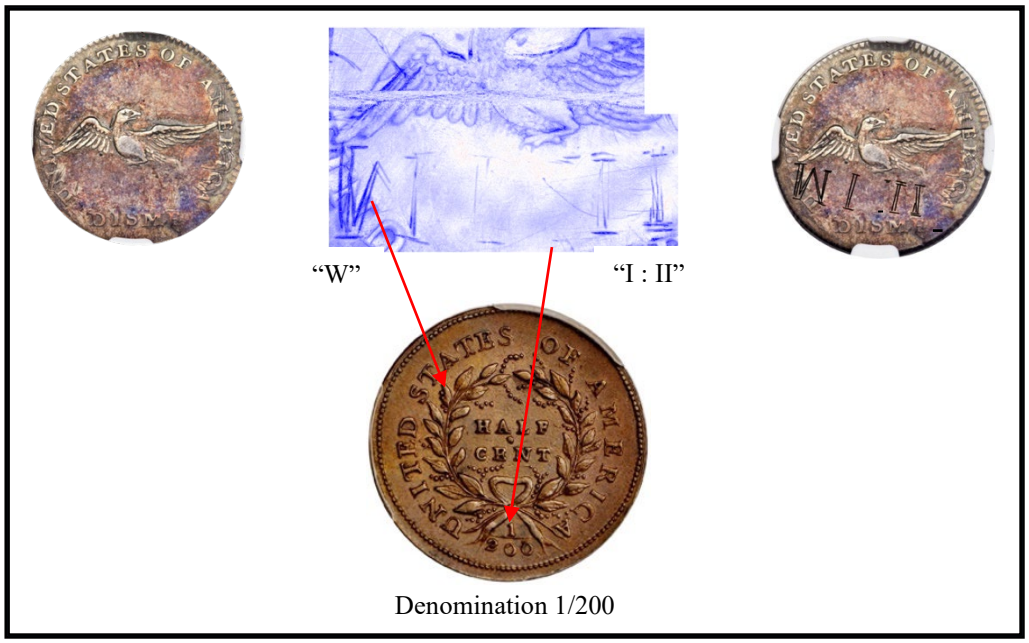


Figure 50. Reverse design comparison to half cent

Figure 51 presents three different types of 1792 pattern cent reverses compared to those of the 1793 half cent and large cent, where the wreath and fractional denomination motif became the standard for these denominations through 1808 and 1807, respectively. The red boxes highlight the fractional denomination at the bottom center. The silver center and small copper cents were experiments while the Birch cent was considered "the real cent," according to correspondence between Thomas Jefferson and George Washington.[12] These 1792 pattern cents may have provided the inspiration for the reverse design, as seen on the Judd-9 silver disme Design Work Surface.

[12] Smith, Pete, Joel J. Orosz, Leonard Augsburger. *1792: Birth of a Nation's Coinage,* 136.

1792 Pattern Cents

Birch Cent Judd-5

Silver Cent Judd-1.

Small Copper Judd-2.

1793 Half Cent Cohen-2

1793 Cent Sheldon-9

Figure 51. Reverse comparisons 1792 pattern cents vs 1793 half and large cents

After nearly 600 hours of μ-XRD scanning, Figure 52 displays the completed scan images of the obverse and reverse where approximately 98% of the etch marks are non-visible or illegible, as a result of Edward Cogan attempting to burnish them away.

THE TOTAL PICTURE

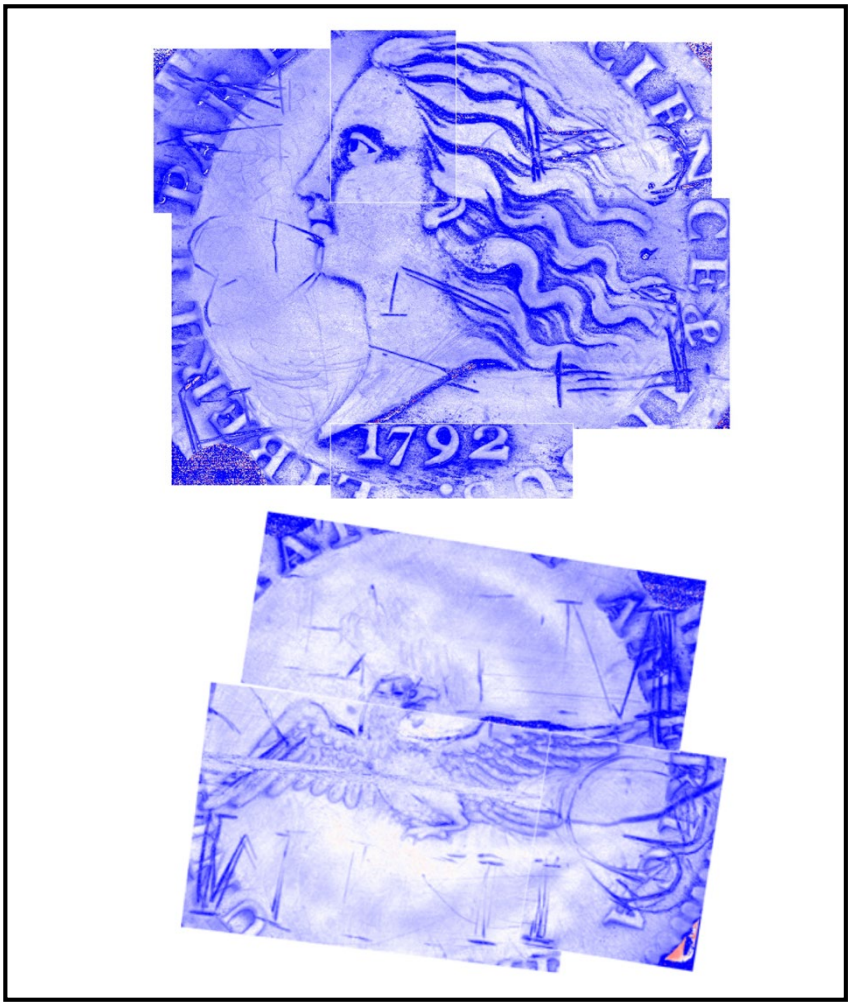
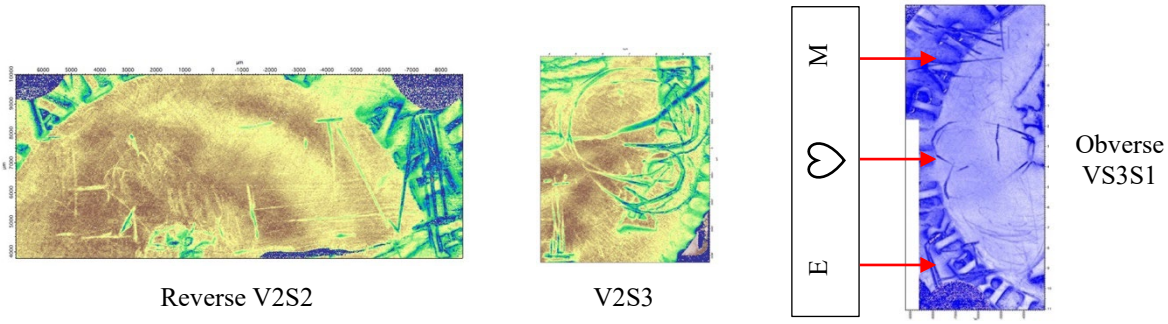


Figure 52. Complete Scan Image

EDUCATED SPECULATION

The last areas to be analyzed in Figure 53 are the regions on both the reverse and obverse that contain what we believe to be love markings, as represented by "E ♡ M." These are similar to those used during the 18th and 19th centuries on love tokens.



Reverse V2S2 V2S3

Figure 53. Expressions of love

After we recovered the "E" and the "M" in V2S2, Wenjun asked, "Who or what might they represent?" Tony and I were not sure so we guessed the "E" could possibly represent an abbreviation of the name Eckfeldt for Adam Eckfeldt, the second chief coiner of the US Mint in 1814, patriarch of the of the "First Family" of the US Mint and who became employed at the Mint in 1796. We conducted a Google search for his wife's name by assuming the "E" was for Eckfeldt. We knew he married Margaretta Bausch about 1799 which meant she would not have likely been the inspiration for the "M." However, we did discover he married Maria Hahn on April 8, 1792, just six days after the Coinage Act of April 2, 1792, Appendix 4. Could this event have given him the confidence to marry Maria because he had excellent prospects for future employment at the new mint? We don't know but we view this as a plausible explanation. Some may raise the reservation that a love token would likely carry the initials of each person's given name, however, according to RelicRecord.com, a love token, "…was used as a proposal of marriage. If a gentleman wanted to get married, he would engrave a coin with the initials of his family's name, along with the initial of the woman's first name."[13] So, there is precedence for this style of designation. I contacted Christopher Eckfeldt, 7th generation, to see if he knew anything about Maria and Adam Eckfeldt's first marriage. He did not so he connected me with his uncle, John Jacob Eckfeldt VI, 6th generation, who is the keeper of the family heritage. I telephoned him in Lima, Peru, and asked him, "Do you know anything about Adam Eckfeldt's first marriage?" His response was, "What first marriage?" He was totally unaware of this fact and was much appreciative that a new branch could be added to the Eckfeldt family tree. He was sad to hear that Maria died in 1795 without having had any children. What I found quite interesting about Chris and John is they each have strong engineering backgrounds, with John being both a geologist and petroleum engineer while Chris is a CNC machinist. The engineering lineage of Adam Eckfeldt continues to thrive within the family.

Given that both sides of the coin contained reflections of love and that their marriage was within six days of the Coinage Act, it seems reasonable to assume that Adam Eckfeldt was likely in a period of marital bliss. Though he would not be formally employed by the Mint until 1796, he was providing services to it prior to his employ. However, in personal discussions with Joel Orosz on

[13] Adams, Will. "Love Tokens Currency of Love." July 1, 2023, http://www.relicrecord.com.

this topic, he holds a contrary view. He argued that Adam Eckfeldt was not an engraver and there was no record of payment for this type of service to him. "Would the Mint have asked a blacksmith and occasional contractor, as opposed to an artist or at least a skilled artisan, to design the half cent in 1792-93? It seems unlikely to me."[14] I had asked previously whether he had any engraving experience or expertise to which I received a negative response. I told him I did. At age five, my father, who was a jeweler and electroplater, gave me an engraving tool with a small silver strip that was held by four prongs of an engraver's ball vise. My mother was quite anxious that I might injure myself, which I did not. I proceeded to engrave my initials "RLR." They were not pretty but they were legible. This qualifies as engraving. Eckfeldt did not have to be a skilled engraver; he may have been acting as a designer or artist with someone else executing the design. Obviously, this is speculation on our part. Joel also argues the love token theme could have been added later, possibly years later, which is a possibility. I would counter that I have lived with this coin for seven years and have viewed it like no other collector or researcher has ever done before. In my opinion, the style and characteristics of the engraving were executed by the same hand. Since the vertical reference lines were completed prior to the 1793 half cent, this would have been in the first year of Adam Eckfeldt's marriage when he was experiencing wedded bliss; thus, we conclude they were likely etched during this period. As to no record of payment, many times subcontractors are not listed by name, so this is a possibility. Finally, being young and ambitious, he could have taken the silver dismes and proceeded to experiment with a design to demonstrate his creativity. Again, we do not know, and may never know. However, another researcher, Don Taxay, ascribed the obverse of the silver disme to Adam Eckfeldt, though this may also be speculation on his part, since he considered it possible that Birch was responsible for the reverse.[15]

In light of the discovery of "E" and "M" from both the disme's obverse and reverse, it seems reasonable to reassess two references that have been typically dismissed by historians. In the first instance, B.L.C. Wailes, writes on December 28, 1829, "Mr. Eckfeldt, one of the Superintendents (the Second in grade) is an artist & has been in the mint from its first establishment. (He) made the first dye used in it."[16] And in the second, there is the quote from the W. Elliot Woodward auction catalog of October 1863, Lot 2021, p. 109, which states in the description of the 1793 half cent being auctioned, "Nearly sixty years since, it was presented to a gentleman by Mr. Adam Eckfeldt, as a specimen of his work, and has remained in the possession of the person referred till within a few days." These two accounts have been discounted as to their accuracy since there are no historical records or other evidence establishing Adam Eckfeldt as an engraver; thus, the reference to him being an "artist" has also been questioned. We believe the etching of "E ♡ M" may be that missing evidence. Interestingly, Adam Eckfeldt would have been familiar with the 1783 Nova Constellatio coinage that contains the legend, "Libertas • Justitia" or "Liberty • Justice." His father was paid to forge these dies in February 1783, and he was likely by his side as an apprentice of 13. Don Taxay views it the same way, "…and that Adam, who served as his father's apprentice, was trained to do all kinds of iron work, and possessed a peculiar aptitude for machinery."[17] Thus, we have his proximity to the mint and statements to the effect that Adam Eckfeldt was involved with the Mint's first dies. In 1796, he became a Mint employee, assistant coiner, and then chief coiner

[14] Joel J. Orosz, e-mail message, June 14, 2023.
[15] Taxay, Don. *The U.S Mint and Coinage,* New York: Arco Publishing Company, 1966, 76.
[16] Moore, John Hebron. "A View of Philadelphia in 1829: Selection from the Journal of B.L.C. Wailes of Natchez." *The Pennsylvania Magazine of History and Biography*, Vol. 78. No.3 (July 1954), 358.
[17]Taxay, *The U.S Mint and Coinage*, 102.

from 1814 through 1839. Adam Eckfeldt was much beloved and revered by those who knew him at the mint and, in 1839, he was honored with this unique gold medal, Figure 54. A pool of $180 was raised to design and fabricate it, along with a few silver and bronze examples.[18] To place this amount in perspective, it would be equivalent to about $592,000 now, assuming a 4.5% compound annual growth rate of appreciation since then.

What we believe is certain about this aspect of our research is that it will likely be debated for years to come.

Figure 54. Adam Eckfeldt gold medal
The Resolute Americana Collection

CONCLUSIONS AND FINAL THOUGHTS

After more than four years of research and scientific investigations at three different laboratories that culminated in the use of the most advanced and groundbreaking scientific instrument ever employed in numismatics, the Argonne National Laboratory's Advanced Photon Source synchrotron, as part of the new field of Cultural Heritage Research, we conclude this Judd-9 F15 NGC is THE Design Work Surface for the 1793 half cent. All elements for the new half cent are appropriately delineated on each side. We believe it and the Judd-9a are the only known surviving DWS artifacts that exist from the first US Mint, and, as such, they are of immense historical numismatic importance, in our opinion.

Our primary conclusion and speculations are supported by the following discoveries:

1. The photo imaging overlay analysis proved that Liberty's bust on the Judd-9 silver disme is exactly that which was used for the 1793 half cent.
2. The photo overlay analysis proved that VR1 and VR2 are the key reference lines that were used to reposition the bust of Liberty and the hair crop for the half cent.
3. The recovery of "L • J" was an important discovery, along with identifying that the "J" or "Justice" was to be eliminated, which shortened the legend from "Liberty • Justice" to "Liberty." Additionally, 1792 pattern coinage designs had made the shift from Latin to English for the new coinage of the United States of America.

[18] Eckfedlt Family Documents. March 15, 1839. Resolute Americana Collection.

4. With the legend now shortened to "Liberty," this modification allowed sufficient room to accommodate the addition of a Pileus.
5. The reverse scan imaging recovered a "W" that we view as shorthand for "wreath" and that "I : II" is also a shorthand abbreviation of the "1/200" used on the half cent for its denomination.
6. We also believe our obverse design flow and reverse design identifications provide new information that was heretofore unknown, given that little historical information remains from the first mint of the United States.
7. We identified a potential linkage between the 1792 silver disme and the 1783 Nova Constellatio decimal pattern coins, given their font style similarities; as such, this coin could be the "bridge" coin between this coinage and the first federal coinage of 1793.
8. We do understand our view that Adam Eckfeldt was the designer of the half cent via this disme will create controversy. However, the likely representation of Maria Hahn by "M" and "E" for Eckfeldt on both sides of the coin and that their marriage was within one week of the founding of the new mint, lends support to our view, given this new information.

Of significant importance, this project demonstrates that synchrotron-radiation-based μ-XRD analysis can be used safely on rare metallic antiquities and that it can be a valuable resource tool in the emerging field of Cultural Heritage Research. Its utilization may uncover other stories that were thought to be lost to the ages. We are hopeful that museums, university collections and other repositories of artifacts consider whether they have appropriate projects that might qualify for acceptance at the Argonne National Laboratory or other synchrotrons in the world. As an outgrowth of this research investigation, the Resolute Americana Chair of American Numismatics at the American Numismatic Society was established to foster a renewed focus on coinage of the Americas.

We would like to share some final thoughts about this experience and what it has meant to us. When I began coin collecting at age 5, local businesses would allow me to search their cash register drawers for coins. This stimulated my imagination. I left the hobby in 1960 at age 12, in pursuit of other interests, and then returned to it in 2014 after a Reno Gazette story about a 1792 silver half disme, the Starr Specimen, caught my attention in 2013. I was fortunate to be able to add it to the Resolute Americana Collection in 2014. I thought I was just retuning to a childhood hobby of coin collecting, but my love of research and investigation, which was cultivated in my forty-five-year career of investment management, would not allow me to just focus on collecting. Tony loves research and the pursuit of knowledge and he brought this excitement to his many years of teaching which inspired his students. His specialty in colonial and Revolutionary War medallic and numismatic history led him to this project and our teaming and ultimately to a close friendship. Never in our wildest imaginations could we have envisioned how this small coin would lead to research endeavors of more than six years and bring us into contact with many talented and brilliant people. The Argonne National Laboratory experience will be among the most memorable episodes of our lives. We were awed and exhilarated by the fact we were able to gain access to one of the most powerful and important scientific instruments in the world. We were amazed by the scale and scope of the Advanced Photon Source. From our first days at the Argonne, it has been a never-ending series of surprises, challenges and rewards. Most importantly, we received extraordinary support by all in this endeavor. In our opinion, the legend on the obverse of the silver disme does reflect the mission of the Argonne National Laboratory which is, "Science and Industry."

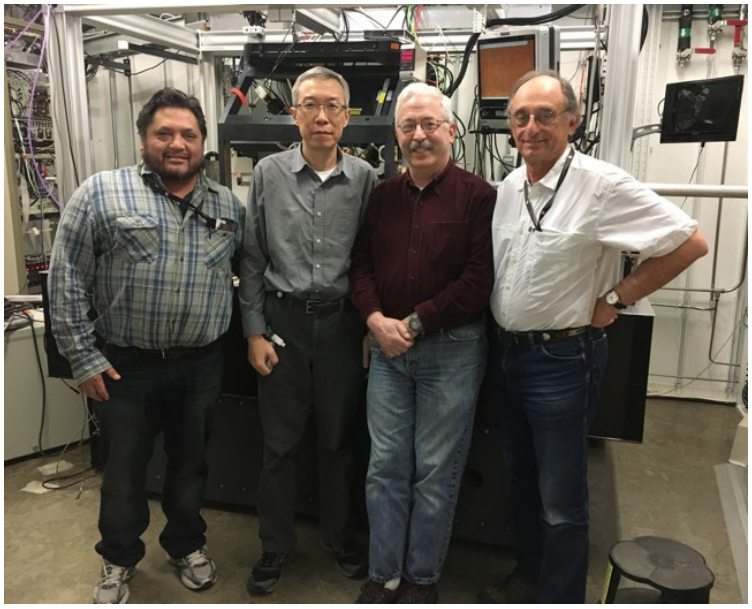


Figure 55. Tony Lopez, Dr. Wenjun Liu, Dr. Jon Tischler and Robert Rodriguez

At the beginning of this journey, we posed this question, "Was this Judd-9 the DWS used to design the 1793 half cent? We believe the answer is a resounding "Yes!"

Judd-9 1793 Half Cent

HISTORY RECOVERED: THE SAGA OF THE 1792 SILVER DISME

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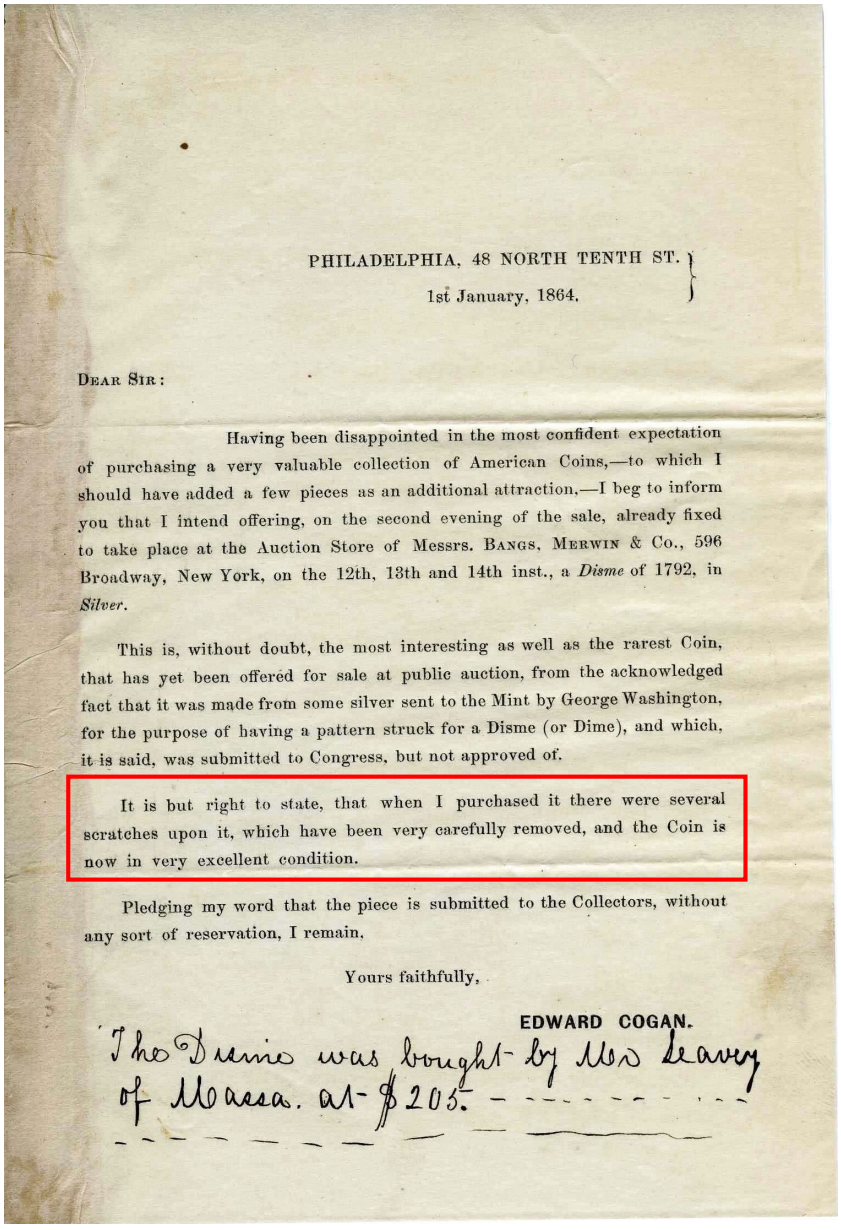
Appendix 1

Edward Cogan letter, January 1, 1864



PHILADELPHIA, 48 NORTH TENTH ST.
1st January, 1864.

DEAR SIR:

Having been disappointed in the most confident expectation of purchasing a very valuable collection of American Coins,—to which I should have added a few pieces as an additional attraction,—I beg to inform you that I intend offering, on the second evening of the sale, already fixed to take place at the Auction Store of Messrs. BANGS, MERWIN & Co., 596 Broadway, New York, on the 12th, 13th and 14th inst., a *Disme* of 1792, in *Silver*.

This is, without doubt, the most interesting as well as the rarest Coin, that has yet been offered for sale at public auction, from the acknowledged fact that it was made from some silver sent to the Mint by George Washington, for the purpose of having a pattern struck for a Disme (or Dime), and which, it is said, was submitted to Congress, but not approved of.

It is but right to state, that when I purchased it there were several scratches upon it, which have been very carefully removed, and the Coin is now in very excellent condition.

Pledging my word that the piece is submitted to the Collectors, without any sort of reservation, I remain,

Yours faithfully,

EDWARD COGAN.

The Dime was bought by Mrs Leavey of Massa. at $205.

Appendix 2

Initial email contact with Dr. Wenjun Liu

APS Beam Line Contact--Bob Field recommended we contact you.

Wenjun Liu
Advanced Photon Source
Argonne National Laboratory
9700 S Cass Ave, Bldg 438E
Argonne, IL 60439

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On 7/13/2017 2:41 PM, roblou270 wrote:
Dear Dr. Liu,

My name is Robert Rodriguez and I am the owner of the 1792 silver disme that we recently conducted EBSD tests at the Colorado School of Mines to see if we could unlock additional subsurface information.

By way background, this coin is among the rarest and most historic coins of our emerging country. For over 150 years, it has been referred to as "marked-up," "scratched" or "graffiti." When I acquired the coin January of 2016, I believed there was a story buried within the coin. Another colleague and numismatic researcher, Tony Lopez, believed the same. We have conducted research on it that has included testing using two scanning electron microscope laboratories in Reno and Denver. After discussions with Dr. David Teter at the Los Alamos National Testing Laboratory, he suggested that we conduct a EBSD test and was kind enough to put me in contact with Bob Field at the Colorado School of Mines.

Bob had reservations about the potential success of this test but we conducted them anyway. We did find some additional information but there is more that could potentially be unlocked. It is with this in mind that Bob suggested that we get in contact with you.

I will send you a photo of the coin in a follow-up email so that you can see what we are referencing. In a week, I will be traveling to Colorado where I will then arrive at the American Numismatic Association annual convention. At the convention, my collection of 1792 coinage will be on exhibit so as to support the release of a new book, "1792: Birth of a Nation's Coinage." This is the largest exhibition outside of the Smithsonian's collection. It is my way of giving something back.

I hope this potential project may be of interest to you and that the final step in our research journey may be completed. Upon conducting the last tests, Tony and I will publish our findings in one or more of the leading numismatic publications. If we are correct in our hypothesis, this is likely the most important numismatic discovery in the past 100 years. We will have proven that this is the only surviving work surface that was used to design one of the first two coins of our republic. Very little survives from our first mint of 1792, including documentation. We hope that our efforts will help to unlock additional insight about our nation's beginning coinage.

Sincerely,

Robert (Rob) Rodriguez

Appendix 3

Initial page of first proposal

APS General User Proposal

Proposal Id: 56401

Printed date: 03/21/2023

Proposal Title: 1792 Silver Disme--investigation of subsurface feature distortions to identify them

Principal Investigator: Robert Rodriguez

Total shifts requested for the life of the proposal: 4

Proposal Abstract

This is a historic project whereby we are attempting to prove that one of the earliest and rarest pattern coins of the first United States mint was used, in our opinion, to design one of the first two coins of the US, a 1793 half cent. Little information remains from this period about the mint's operation so that unraveling this coin's hidden information would add significantly to our historical understanding of the coinage development process.

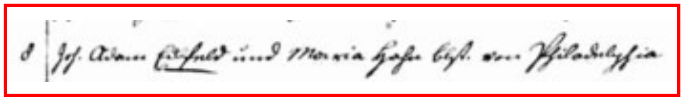
1792 pattern coins are among the rarest in US numismatics and they reflect the first attempts of creating our nation's national coinage. Several of our founding fathers were involved with this project. It has been determined that Thomas Jefferson provided the silver for our first circulating coin, a 1792 silver half disme. 1792 pattern coins were created with denominations from one cent to a quarter. They are of extreme rarity, between 1 and 18 of each, are among the most prized in the field. There are only two silver pattern dismes in existence and they are the size and weight of our first 1794 production dime. You will note that I use the term "disme" because this is what was proposed in 1792. 1792 pattern coins consist of denominations one cent to a quarter, with surviving populations between one and eighteen. They are among the most prized and historically important of US coinage.

This project initially began by having discussions with Dr. David Teter, Division Leader Materials Science and Technology, at the Los Alamos National Laboratory. Since this type of analysis could be done in the private/university sector, Los Alamos could not be used. Dr. Teter was very helpful in directing us to other experts. American Assay Laboratories of Reno, Nevada, conducted the first SEM test utilizing an Aspex Corporation SEM, with a BSED, a Everhart-Thornley SED and a FEI Omega Max SDD Dispersive Spectrometer. Only limited information was uncovered but this testing did confirm our initial size measurements of several of the markings. Dr. Teter than directed us Dr. Robert Field, Research Professor Dept. of Metallurgical & Materials Engineering, at the Colorado School of Mines. Under his direction, a Helios NanoLab 600i was utilized to conduct EBSD testing. Through this process, additional information was gleaned about the reverse of the coin. We were able to determine that in quadrant 3, what looked like a "W" was in fact a "W." This was good news for Dr. Wenjun Liu since he believes that with the equipment at the APS, virtually 100% of the material distortions in the various fields can be recovered.

Appendix 4

John Adam Eckfeldt and Maria Hahn marriage record, April 8, 1792

Pennsylvania and New Jersey, U.S., Church and Town Records, 1669-2013 for Joh Adam Eckf...
Save
PA - Philadelphia › Philadelphia › Not Stated › Saint Michael's and Zion Church
1298 of 3053
© 1997-2023 Ancestry.com
Joh Adam Eckfeld
Pennsylvania and New Jersey, U.S., Church and Town Records, 1669-2013
Detail
Related
Source
Name Joh Adam Eckfeld
Event Type Marriage
Marriage Date 8 Apr 1792
Marriage Place Philadelphia, Philadelphia, Pennsylvania, USA
Organization Name Saint Michael's and Zion Church
Spouse Maria Hohn
Add Additional Information
Others in Record
Maria Hohn



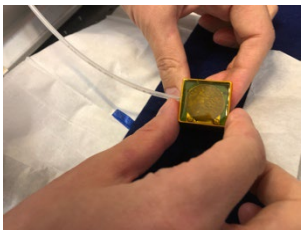
Appendix 5

Birch Cent Judd-5

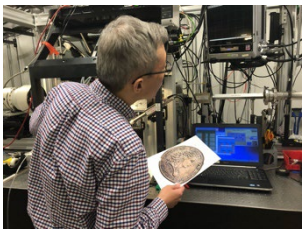
Visit 4. Scan V4S5. (November 17-18, 2018.

We wanted to scan the target areas to determine whether there was any subsurface information that might explain the planchet marks. Were some of these made intentionally or were they just ordinary planchet defects? Because we had limited time, a 12-hour scan was completed in the green rectangle area at pixel step size of 60 microns. In addition, an X-ray beam of 12 keV was used for a small area scan. At this lower energy level, the beam would penetrate to about 10-12 microns in brass. Since brass is a much harder alloy than sterling silver, if there were any subsurface metal lattice deformations, they would likely occur at a shallower depth.

Designated Scan Area

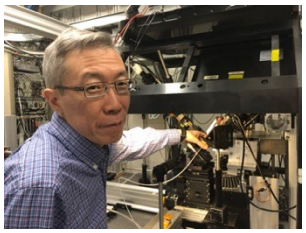


Helium encapsulation



Wenjun Liu

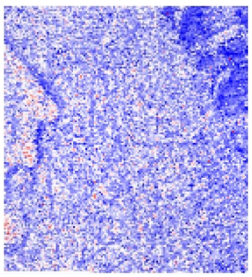
Birch cent in chamber



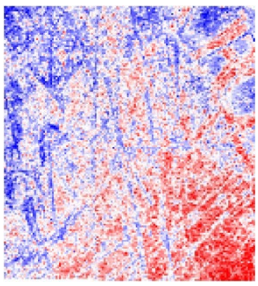
Liu positioning coin

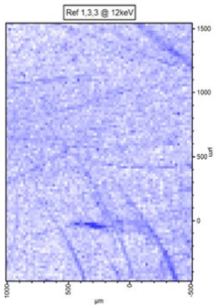
Target scan area

The scans below show there were no subsurface deformations that would have been caused by actions applied to the surface; therefore, we concluded the surface marks were the result of an imperfect planchet.



8.4 mm x 9.2 mm





1.5 mm x 2.0 mm